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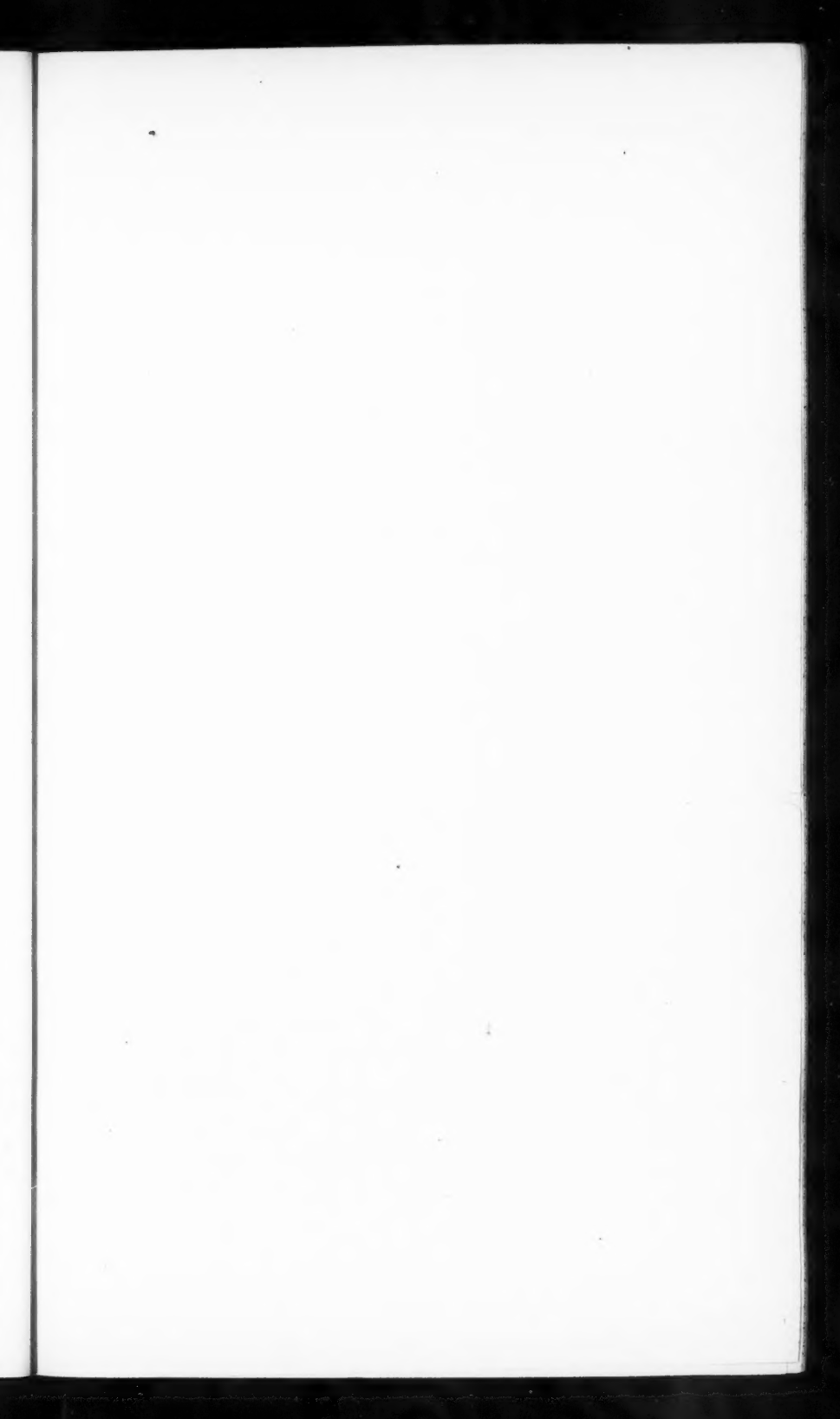
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THE PINE SNAKE OF NEW JERSEY.

BY REV. SAMUEL LOCKWOOD, PH.D.



IN the "pines" of southern New Jersey, which probably is the northern limit of the species, is a notable serpent, reputed to attain the great length of nearly twelve feet, and whose body is then, in common parlance, "as thick as your arm," or in more moderate speech, from three and a half to four inches in diameter. Not that the writer has seen any of such dimensions, but he gives what may be called the mean of popular observations. This reptile has a shiny coat of a soft creamy white, upon which is laid, much in the Dolly Varden mode, showy mottlings or blotches, which, beginning at the neck, are of an intensely dark brown or chocolate color, but which toward the tail lighten up into a pale bright chestnut. Such is the pine snake; and its habitat and traits are well expressed in the beautifully significant name which science has given it — *Pituophis melanoleucus*, which literally means, "the black and white serpent of the pines." If one consider the formidable size it is said to reach, together with its notably harmless nature, and the splendid adornings of its scaly armature, distinguished mention must be made of this reptile, as the most remarkable serpent of the Eastern States.

The first time I saw the pine snake alive was eighteen years ago. I was on the steamboat going from Keyport to New York. It was the berry season, and persons from the pines were on

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board taking their eggs and "huckleberries" to the city market. The Pines, so called, had not up to that time been visited by me. "Farrard" of the boat, being the place where the hucksters, farmers and fishermen most did congregate, was a sudden and unusual commotion. One solitary woman held her own in this crowd of men. She was from the Pines, and in her way was an intensely thorough-going business body. She had a wagon-load of eggs and berries, which latter she had bought of the pickers, and on them she expected to "realize" handsomely. The assistant captain, an elderly and corpulent man, was collecting the fare. Approaching the female huckster, whom he knew well, he accosted her with "Come, Peggy, your fare." "Yes, Cap'en, but jist hold my comforter till I git my pus out." And in a trice a pair of pine snakes, concealed beneath the woman's shawl, were slung around the captain's neck. The old man's example was electric! Such accelerated evolutions! It seemed neck or nothing with everybody but the huckster woman, who sat shaking with laughter. She had retained hold of the reptiles by the tails, so that they were left in her hands. She was taking them to Barnum, who probably would give her a few shillings, and a few tickets to his show. Prof. Baird had just before requested me to get a pair of these reptiles for the Smithsonian. My mind was made up that these should go to the Professor. At this juncture a fisherman whispered into the woman's ear, "Keep your eyes skinned, Aunty, a science man's around." The woman became at once very exacting. I bought the pair at an unreasonable price; but an accident prevented their ever seeing Washington. They were of both sexes, I think, and were about three and a half feet long. Their harmlessness surprised me. Even my little children played with them. Indeed the late Prof. Torrey, a good many years ago, had a pair that were allowed the freedom of his study floor. The female of my pair laid seven eggs, each about five-eighths of an inch long. From their size they must have been premature.

Three summers ago a friend captured a fine female specimen and sent me. It was in good condition, nearly six feet in length, and as thick as my wrist. To my surprise the beast was incorrigibly irritable, and kept up a vicious blowing, and darting at me, each time hitting her nose against the glass cover of her box, so that, much to my grief, she knocked off the hard scale on the tip of her snout. The cause of this unexpected conduct was not far

to seek. The poor thing had the cares of maternity coming upon her. On the 18th of July she laid twelve white eggs; and a beautiful sight did they present. There were two clusters, the eggs adhering to one another. Two of the eggs were under the average size. These seemed to have been laid first. There was one still smaller which seemed to have been laid the last. In one of these clusters were seven eggs and in the other five. I was astonished at their size. A single egg measured twenty-two lines in length, and sixteen in width. They were in fact as large as the eggs of an ordinary bantam fowl. One of them weighed 543 grs., and the whole weighed about fifteen ounces avoirdupois. They were of nearly the same form and size at each end, except that at the upper end, or the end last evicted, was a little cusp, or teat-like prominence, precisely such as characterizes the fossil coprolites, and due to the same cause, the nipping off, or closing up of the cloaca, as the egg in its soft condition passed out. The eggs at this precise moment must be quite soft, as they were agglutinated together side by side. An attempt to separate a pair succeeded in pulling off a portion of the shell which adhered to the other egg. In this regard the resemblance to insect eggs was striking. The shell had a fine and pretty marking, as of reticulation.

An attempt was made to hatch the eggs, but without success. They were put in a box of sand, which was moistened, and every effort made to preserve the proper temperature by keeping it warm; but the eggs perished. It is curious that in all my inquiry of the old settlers in the Pines, I have learned nothing about the eggs of the pine snake, — no one, so far as I could ascertain, had ever seen them.

It is interesting to observe the pine snake drink. It lays its head usually flat upon the water, letting the lower jaw just sink a little below the surface, when with a very uniform movement, the water is drawn up into the mouth and passed into its throat. It is the same as the drinking of a horse; that is, it is a true drinking. With a snake, lapping is an impossibility; the form and position of the tongue are unsuited for such an act. The tongue of a serpent is like a flattened cord, divided at the forward end into two pointed threads as soft and flexible as silken fibres. This delicate organ is projected from a round orifice in the middle, and somewhat forward of the trough or hollow of the lower jaw. And

a very beautiful functional arrangement all this is: for as might be conjectured, when swallowing its prey entire, the tongue must be put out of the way. In this emergency it actually disappears from the mouth altogether, being withdrawn at the orifice mentioned. Drinking, with the pine snake, is a slow affair. I have several times watched it by the clock. Once it drank exactly five minutes without taking breath. It then paused, looked about for three minutes, and went at drinking again, occupying precisely five minutes as before, thus making ten minutes. The amount of water drank was a little over a gill. Previous to this drinking she had been without water four weeks.

The reptiles have seemed to me specially to be capricious and fastidious about feeding in confinement. The pair of small pine snakes mentioned at the outset ate young chickens just from the nest, but would not touch mice. My large one for a whole month after laying her eggs had not eaten anything. A young chimney swallow was given her, but, though the little thing fluttered and cried, she took no notice of it. A young chick three days old was offered, nor would she notice it. Both birds were removed unhurt, in fact, untouched. A rat with a limb broken by the trap was next put in her box. Her attention was at once aroused. After looking intently at it for a minute, she made a sudden dart, striking the rat on its side with her nose. With a squeak, the poor thing turned its face towards its grim assailant. The latter with head erect, but motionless, and tongue quivering, kept its eyes steadily on its victim. There was a sudden spring, and the rat's nose was in the grip of the monster's mouth. Quickly, but deliberately, the snake held its victim against the side of the box; then setting the sharp edge of each of the long scuta or abdominal scales on the floor, as a fulcrum, brought a part of its body, like the convex side of a strong bow, against its prey, forcing it to the side of the box with a compression that made the bones of the rat give a crackling sound. The suffering of the victim was but for a moment, as I have no doubt that the spine was broken instantly. Although the prey was quite dead, there was still that singular deliberation, and several minutes elapsed before that compression was relaxed. Quietly now the snake began the act of swallowing its prey. It commenced with the head. The action of the creature is very interesting. It is not by a uniform movement of the entire prey that the swallowing is performed. The snake opens

its mouth widely on one side, and then gives a slight hitch with its outer teeth, or the teeth on the opened side of the mouth. This done the mouth is kept closed on that side of its prey, and the other side of the mouth is now opened, and the same hitching gone through; and so the action is alternated, the hitching being about two minutes on each side by turn. It is pretty much as if the finger of a tight thread glove should be drawn on by using the nails of a thumb and finger successively on the sides. This is a beautiful mechanical movement, by which the force applied is admirably economized, a prime consideration when food in a mass much larger than the head and neck of the snake is to be passed entire through the gullet. The swallowing is so extremely slow that the movement is practically imperceptible. With watch in hand I found when the hind legs of the rat disappeared twenty minutes had elapsed since the swallowing began. The tail of the prey is the last to disappear. But in the final movement the mouth of the snake takes no part. The body having passed the gullet there is a vigorous muscular action along the long thorax. To our astonishment we now heard again that singular crepitating sound which resembled the breaking of the bones; could it be the breaking of the ribs? In slowness of eating and drinking our ophidian fulfils strictly the precept of the most exacting hygienist. But what about the breathing for those twenty minutes during which the entire throat was closed as tightly as the wadding stops up a gun? Surely for the time being respiration was absolutely checked. As if to make up for this estoppel of its breath, the creature is now gaping so widely that a fine opportunity is afforded to inspect the interior of its mouth.

A fact observed here, as also when I fed the smaller ones with birds, was that the snake did not beslime or lubricate its victim before swallowing. I had expected to see this, for I once caught a large black snake, *Bascanion constrictor*, robbing a nest of young birds. The nest was in a hummock of grass in a swamp. It had two birds on the ground, one of which was literally enveloped in white slime, like a fly in a cobweb, and the other was in process of lubrication. Unfortunately the snake saw me, and the process was stopped, as the animal now tried to escape.

By the old settlers in the Pines, this reptile is often called the bull snake, because of the remarkable sound it makes when blowing. A case was told me of a large pine snake being captured by

a farmer's boy, who tied a string around its tail, and having taken it home, tied the string to a small bush near the kitchen door. Not intending anything, the boy said nothing about it. As the family were at supper, the snake commenced blowing. This was heard by the good mother, who cried out, "There, that bull's got into the corn field again!" The boy broke into laughter, and then told what he had done. And well do I remember my boyish terror at hearing a similar sound. It was the restrained bellowing of a bull, which came upon me suddenly in a field. There is nothing sibilant in this blowing of the pine snake, not the slightest hiss about it. The animal slowly fills its long thorax with air, and then expels it with a bellowing which is really formidable.

Observations made on an animal in confinement should be weighed accordingly. A fact given me by an old resident in the "Pines" would indicate that the pine snake is a great feeder. He said he saw one killed, out of which were taken two young rabbits and twelve quail eggs (the eggs may have been her own). This snake likes to get under barns, without doubt in quest of rats and mice. But for the above statement, I might have inferred from my specimen that the species is a moderate feeder, as it often refused food offered it. About a week after the swallowing of the two rats I put a live one into the snake's box. She was not hungry, and was evidently annoyed by the rat's presence. So she made a dart, striking it on its side. The rat, plucky in its terror, turned upon and bit its assailant. This was a new experience to the reptile, and momentarily dazed with incomprehension of the situation, it recoiled upon itself. It was, however, beside itself but for a moment, for it instantly became alive with subtle action. The tongue quivered with excitement, and that living cable, which made up those fearful coils, began a rapid thickening. The creature seemed to be inhaling air down its whole length. Now began that fearful blowing. It was truly a bellowing of snakish rage, and was followed up by a savage dart at the innocent intruder, which gallantly returned the compliment with another nip of its sharp teeth, sending the snake back in haste to the farther corner of the box. I noticed that the rat was in nowise stupefied, or affected in any way corresponding to the so-called fascination of serpents. Keeping its head raised, eyes fixed and tongue quivering, the snake filled with air again; then again

came that appalling sound, and another dart, with the same response from the rat. I cannot depict the seeming tussle of each round. It was not so much on either part an effort to close in, as it was to deliver its own shot, and then get out of the way, so that on the part of the snake each charge received caused a squirming that looked like a wild beating of the air. She went at the poor rodent again and again. Matters were waxing desperate. The rounds were quicker and more severe. There was less blowing and harder fighting. I was now desirous to separate them, but knew not how to bring it about. The truth told, I was getting to be somewhat nervous about the personal appearance of my beautiful serpent, which seemed in great peril of bodily damage. At last both combatants seemed sick of their bargain. So there was a temporary truce, which intermission of hostilities, as it often is with wiser bodies, was made the opportunity of a mutual effort to escape, the rat inspecting every part of the box, and gnawing at every crevice; the snake butting her nose in vain attempts to break through the glass. The truce lasted ten minutes. The rat was sitting quietly in a corner cleaning its face with its paws. The snake had ceased its vain darting at the glass cover, and, as if for rest, had spread itself over two-thirds of the floor of the box. It seemed as if a fair understanding had been reached, and that hostilities were really at an end. It was a treacherous calm. Incited by some cause the rat made a run for the opposite side of the box. Alas! this movement was the one fatal error of this little hero's life. In attempting this, it had to cross over a portion of its enemy's body. It was the merest touch, but that touch was death. Instantly every particle of the serpent's body flashed into activity, as if the whole had been powder, and a spark of fire had fallen on it. In the merest fraction of a second of time, the reptile that seemed to be lying so languid was transformed into an inverted nest, under which was the poor rat. I looked for the head of the snake. It was under this living nest, holding at the hinder part its victim, which was doubled up in this strange compression. And stranger still was the wonderful adjustment that a half minute of time sufficed to accomplish. The inverted nest of coils opened at its upper or convex end, like the crater of a miniature volcano. Out of this was evolved the head and front feet of the little rodent, whose dark lustrous eyes stood out and neck grew thick from the fearful compression. As the

pretty little flesh-colored hands lay upon that fatal upper coil, it did so look like the intercession of helpless suffering with pitiless power! This terrible constrictor, although the act was done in an instant, had fully exhausted all her ingenuity in throwing up this fearful engine of strangulation. It was not merely a series of nest-like constricting coils, but one great coil went transversely over all the others; as when the hand squeezes a lemon, and the other hand is made to help the compression. One could hear the bones crack! All this time the head of the serpent is underneath, holding its little captive in place, while that spiral vise squeezes out the brave little life that has so stoutly held its own against such odds in a mortal combat of two long hours. Happily death is almost instantaneous, for it is a literal crushing out of life.

Eight minutes have elapsed, and that spiral coil is still wound up, rigid and motionless as a rope of iron. How patient the creature is! So still, so quiet, one would hardly think it was alive. Now it withdraws its head from underneath the coils. This releases a part of the transverse fold, and gives to the head ten inches of free movement. That head is raised above its prey, and is there set at the extremity of an impending and motionless curve. Nor is there the least aspect of snakishness about the act, but a certain quiet air, as though the reptile was conscious that the thing was done. A change comes at last. The head is still aloft, the eyes are fixed on its victim, the neck and part of the long thorax swell with inspiration; then comes that indescribable blowing. It is evidently taking a good long breath after a tough job. There may be in it a relief to its nervous excitement. Is there in it any exultation? Who can tell? Now comes a slow, but general slackening, or relaxing of the coils. The head, however, is still kept aloft with the eyes set upon the little mangled body. As the upper coil opens the victim lies on one side, as if in a nest. The snake lowers its head and touches it with that delicate bifid tongue, which is doubtless an organ of acute feeling. Then it rubs its head against the dead little hero, pushing the head into, and moving it all round the coil for that purpose. This toying with its victim lasts about four minutes. At length the coils all slacken, and *Pituophis* stretches herself out for repose. She is now utterly indifferent about her conquest. We left the rat in the box until next day, when it was removed and subjected to a *post mortem*. I found the vertebrae dislocated in three places, one

place just back of the neck, and two places in the dorsal region.

Early in the second summer a splendid male *Pituophis* was sent me. It was seen swimming across a stream, and was captured after landing. It was about six feet in length. But a few minutes before an equally fine specimen was killed in the same place, and the belief was that this was its mate. The coloring was very bright, showy splashes of pale chestnut predominating. I put it with my female specimen. They took no notice of each other, though kept together until May of the next year, when the male died. I think it got some rough handling in its capture, from which it never recovered.

Old charcoal burners in the Pines entertain the belief that the pine snake destroys the rattlesnake; but I have never found the man that had seen the pine snake kill a rattlesnake. They say that generally they can tell if a rattlesnake is around by the smell, which is like that of a cucumber. That the pine snake can emit an odor of a far more powerful character than the rattlesnake, is well known to these men. Their notion is that the smell is thrown out with the breath when blowing. This I think is a mistake, except the fact that it may occur during the blowing, which is itself an act or manifestation of rage or other high emotion. There was a man in the Pines who kept up an objectionable familiarity with the snakes. He would put a black snake inside his hat, then go into the hostelry and banter some of the loungers to knock off his hat, an accommodation which was soon granted, when a display of Gorgon locks of raven hue would result, that constituted him, for the nonce, sole occupant of the premises. Such coolness would make any one a good observer. This man said he fell in with a very large pine snake in the woods. His words very nearly were, "You can tease a pine snake with a stick, and instead of trying to get away, it will coil itself, and give up. So I took a long stick and began teasing it. It reared itself, and began blowing (bellowing) fearfully, and there fell on me a stench so sickening, that I could not stand it. It seemed to rain on me! I turned and ran away as hard as I could! That the adult snake has this singular power must be accepted. The same experience has been given me by many others, and I have myself experienced it, though in a faint degree. I am not disposed to believe that it comes from the animal's mouth, however, and think that it can be

determined only by dissections of the posterior parts. This faculty may be compensatory — a means of defence for an animal naturally timid. And may it not be also for sexual attraction? In this particular it is probable the pine snake is not singular, and it is likely that where this function is feeble in the other snakes, it is strong enough for the latter purpose. A man very much beyond the average intelligence and education, a teacher in the Pines, said to me "I once saw a black snake come out of the woods into the soft sandy road; and it acted precisely as a dog does that is nosing out a scent. The snake came to a snake's track in the sand. It at once put itself in the track, and began to follow it; when, seeing me, it turned off to the woods and got away."

As is well known, the capacity of abstinence from food is remarkable among the serpents. Late in September, 1874, I killed a mouse, and gave to the female *Pituophis*. She seized it, gave it the usual squeeze, then swallowed it, taking just five minutes for the latter task. The next day I gave her another dead mouse, with exactly the same results. This was the first time that she had broken fast since September, 1873, — just one year before!

She had in the previous year on one occasion eaten a good-sized rat, that was given her dead, taking eighteen minutes for the operation. And I must mention here that I have known the Flat-head Adder or Blowing Viper, *Heterodon platyrhinos*, to eat the heads of the common eel, left on the shore by the fisherman. So that the assertion that snakes will not take food that they have not killed themselves, is not in all cases correct.

Late in August, 1873, I noticed that the snake seemed sickly. The dim, horny look of the eyes told the reason. She was nearly, if not quite, blind; and was about to cast off her old skin. To me, this was a time of anxiety, I was so anxious to witness an operation which I had never seen. On the 30th, owing to a restless night from illness, I rose later than usual. Went directly to the snake box — what a disappointment! The snake had cast her skin, and was now all aglow in her new winter dress. I was struck with the wonderful clearness of the eyes, and was reminded of the shoreman's slang, as previously given. I now saw a new significance in their vulgar speech; and it occurred to me that many a poor ophthalmic sufferer would rejoice if he could thus exuviate his optics.

But the desire came at last. Near the close of September, 1873, at 1 P.M., looking into the box, I saw that the snake had started the skin from her head. It was a little torn at the snout, and I found that the head and neck were denuded for about two inches. The denuding process was going on, but very slowly. Doubtless the chief difficulty was in starting the skin, and I felt sorry that I did not see the start. The neck was slowly becoming divested of the old cuticle, which, at first glance, had a sort of rolling aspect. What surprised me was the fact that there was not the least friction in the act; that is, there was no rubbing against any exterior object. As the old skin at this time is very moist and soft, any swelling of the body stretches and loosens it. So soon as the exuviation has reached the part of the body containing the larger ribs, this doffing of the old suit proceeds more rapidly, and with a singular system. It is done just in this way. Exactly at the place where the skin seems to be moving backward, a pair of ribs expands. This action enlarges the body and loosens the skin at that place. In this movement both ribs in the pair act at the same time, just as the two blades of the scissors open together. Now comes in a second movement of this pair of ribs. One of them — say the one on the right side — is pushed forward, and made to slip out of the constriction, when it is immediately drawn backward, that is, against the neck of the old skin. Now the left rib makes a like advance, and in a like manner presses backward. Thus the final action of the ribs is not synchronous, but alternate. And how notable becomes the sameness of result in this action with that of the alternate hitching of each side of the mouth when swallowing. Indeed, swallowing by a serpent is a misnomer; for that laborious hitching is not a pushing of the prey down the gullet, but a drawing of the body over it. The western man said, he always felt better after getting himself around a two-pound steak. With the serpent, this is a literal fact; it puts itself outside of its victim. And so with the singular action of the ribs—it seems to push the skin backwards; but this is an illusion, for it actually pushes itself forward, and advances out of the skin, thus with each movement or advance, lengthening the double cylinder behind; that is, the old hose evolves from itself forward, though it appears to be rolled on itself backward.

The ribs of a serpent, which extend very nearly throughout its whole length, are very much smaller in the neck and tail. At

these parts exuviation is much slower than when the larger ribs have play. This rib action produced a singular automatic movement of the serpent on the floor of its box, and even across the folds of its companion, which kept as still as if it were dead. The movement of the snake's body, as the skin did not follow it, gave the creature the appearance of crawling out of a tubular case. The skin of course was presented inside out, so that every scale showed its concave side, which was true also of the scales of the eyes. To all this was one exception. The last scale of the tail is a hollow pyramidal, or four-sided spike. It is fully half an inch in length. This, for plain reasons, was not inverted. The entire process of exuviation, allowing five minutes for the part that I did not witness, took thirty-five minutes.

There was a great contrast of color and brilliancy between the old and the new attire! Unversed in serpentine psychology, we are not able to say what went on in the caput of this creature, which the adage has made so famous for wisdom. With a dress of such a rich creamy glow, and such adornings of brown, and chocolate, and chestnut, what blame if it were proud of its new attire? She certainly seemed to show her feelings in a feline way, for she rubbed her head, with a seeming cat-like complacency, against that of her companion. As for him, poor fellow, he had been ten weeks trying to get his trousers off, and after this panting time, had only succeeded in tearing the garment. He seemed now to be acting like that human, who, after a vain tussle with his tight boots, retired to allow his mind time to regain its composure. The truth told, it took Mr. Pituophis exactly three months to get off his pantaloons. It would only come off in bits at a time, and by painful friction, which, as shown above, is not the normal way of a snake's undressing. Indeed, it looked as if a valet would have to be provided. But on the 13th of October, a warm Indian summer day, he was successful in doffing his old vestment. Having got out of those dilapidated tights, he looked more comfortable, and in his new suit appeared a very presentable fellow.

Even in its excrementing, it observes a singular method, which, however, is perhaps not peculiar to itself. In every instance — and I have made a number of observations — the first voiding is a clear liquid. This would make a circular spread on the floor of the box, about as large as one's hand. In the middle of this was immediately voided a heap of a uniform granular powder, of a

deep straw color. This was about as wide as a dollar. On top of this was a smaller mass composed entirely of hair, unchanged from its natural color. This was the indigested portion of its last meal. This excrement was made three weeks after its meal of two rats. It is to be remarked, there was not the smallest bit of indigested bone. I regret that my intention to secure chemical analyses was not carried out.

When the summer was advanced I put into the box a fresh sod of grass. After a while the snake became very fond of it, but its first acquaintance with it was the occasion of a singular demonstration. The stupid thing at once assumed an attitude of threatening inquiry. It raised its head aloft, and in the direction of the strange object, vibrating its tongue, and keeping its eyes intently fixed upon it. That head, and the part of the body thus elevated looked as rigid as if cast in brass. And for a full hour was that statuesque rigidity of posture sustained. How much longer I know not, as I was called away. This singular command of the muscles is probably peculiar to all the constrictors. The common black snake can be taken in the hand by the lower part of the body, and the rest of the animal be projected forward, of its own will, in a straight rigid line. Owing to this command of the muscles the pine snake is capable of performing some evolutions, which are not only beautiful, but so intricate and delicate as to make them seem imbued with the nature we call spiritual. I have often seen the *Pituophis* spread out in loose coils with its head in the central one, wake up after a long repose and begin a movement in every curve, the entire body engaged in the mazy movement, with no going out, or deviation from the complicated pattern marked on the floor. Observing this intricate harmoniousness of movement, I thought of the Seer's vision of the mystic wheels. Those revolving coils—"As for their appearances, they four had one likeness, as if a wheel had been in the midst of a wheel." In the popular pictorial tablets of Natural History in Japan, their generic idea of a snake is given in the words *Kuchi Nawa*, "Rope with mouth at end." And this is pretty much the crude popular conception of an ophidian the whole world over. But the movements of a serpent are never started rope-like at one end, and thus transmitted to the other; nor is the movement like the force-waves sent through a ribbon vibrating in the air. The movement consists of numberless units of individual activities, all reg-

ulated by and under the perfect control of one will, that is felt in every curve and line. There is some likeness to the thousand personal activities of a regiment seen on their "winding way." And all this perfection of control of so many and complicated activities is true, whether a serpent like an ogre be crushing its victim's bones, or as a limbless posturist be going through its inimitable evolutions. In our thinking a serpent ranks as a paradox among animals. There is so much seeming contradiction. At one time encoiling its prey as in iron bands; again assuming the immovable posturing of a statue; then melting into movements so intricate and delicate that the lithe or limbless thing looks like gossamer incarnate. In this creature all the unities seem to be set aside. Such weakness, and such strength; such gentleness, and such vindictiveness; so much of beauty, and yet so repulsive; fascination and terror:—what need of wonder that whether snake or python, the serpent should so figure in the myths of all the ages, and the literature of the whole world! Yes, in the best, and the worst thinkings of men!

BOTANICAL OBSERVATIONS IN SOUTHERN UTAH, IN 1874. I.

BY DR. C. C. PARRY.

THE hastily gathered collection of plants made by Fremont on his adventurous return trip from California, in the spring of 1844, contained quite a number of remarkable new forms, from the little known district adjoining the valley of the Virgen, then included in the Mexican Territory of Upper California. Several of these newly discovered plants, as far as the imperfect material allowed, were described by Dr. Torrey and Prof. Gray, in Fremont's Report, "*Plantæ Fremontianæ*," and other scientific publications. Subsequently the inaccessibility of the country, and the hostile character of the Indian tribes occupying this district, prevented for a time farther botanical researches. With the growth of Mormon settlement gradually extending southward from Salt Lake, the obstacles to exploration were in great measure removed and the valley of the Virgen lay along the line of one of the travelled routes to southern California. During this period, late in the year

1855, a French naturalist, named J. Remy, passed over this route from Salt Lake to Los Angeles, and made a scanty collection of plants on the journey, which were afterwards deposited in the Paris Museum. His published narrative, entitled "*Pays des Mormons*," contained only very general allusions to the botany of the region traversed, and no scientific account was given of his collections, the material being apparently imperfect and fragmentary. Since then, up to the year 1870, we have no account of any botanical collector visiting this district. At the latter date (1870), at the suggestion of the writer, Dr. E. Palmer, then in the joint-service of the Department of Agriculture, in Washington, and the Smithsonian Institution, was induced to visit this section on a collecting tour, extending to the mouth of the Colorado and the Pacific coast. Leaving Salt Lake in the latter part of May, he spent about three weeks in the vicinity of St. George, collecting in that vicinity a number of new species of plants which were mainly described in Mr. Watson's Botanical Report of the geological exploration, 40° parallel, vol. v.

In the following years (1871-2), the expeditions of Lt. Wheeler and Major Powell, both touched on this district, and small collections of plants, made by Mrs. E. P. Thompson, Capt. Bishop and others connected with these surveys, added several new species to the flora of this district, being described by Mr. Watson in the *AMERICAN NATURALIST* (Vol. vii, pp. 299-303).

In addition to these published sources, several local collectors have at different times aided materially in extending our knowledge of the plants of this region, among whom may be mentioned as especially worthy of notice, Mr. A. L. Siler, and J. E. Johnson, Esq., both residents of southern Utah.

Being desirous of obtaining a more complete view of the botanical features of this district, and especially of securing the evanescent spring plants, which on account of the late season of gathering or hasty mode of travel, other collectors had mainly neglected, the writer undertook a botanical collecting tour, early in the present season (1874). It seemed like anything but a promising prospect for the success of this enterprise, to encounter on my arrival at Salt Lake, March 20th, a snowfall of nearly two feet, interfering seriously with the ordinary means of travel, and rendering the journey over the high intervening country, between Salt Lake and St. George, a distance of 350 miles, exceedingly tedious and disagreeable.

Not before passing over the rim of the great basin, within a short day's travel of my destination, was there any appearance of advancing vegetation; but on dropping down suddenly into the valley of the Virgen, on April 5th, the whole floral aspect assumed a change almost magical; orchards in full bloom including peach, almond, and apricot, marked at a distance by a perfect blaze of blossoms the scattered settlements, while the lucerne fields with their deep green foliage were nearly ready for a first forage crop.

Over the intervening desert table-land the aspects of advanced spring were evidenced in rainbow-colored patches of *Phacelia Fremontii* Torr. and bright yellow clusters of *Eunanus Bigelovii* Gray (No. 147). The approach to St. George, which I had previously selected as the central point of my explorations, was at this season, and under the circumstances of the case in contrast with the bleak country just passed over, peculiarly attractive. The variety of rock exposure in the form of steep mural cliffs of red sandstone, and high basaltic *mesas*, with their slopes of broken *talus*, gave promise of a rich harvest, which the result of my labors fully realized.

From the 5th of April up to June 1st, there was a continuous succession of interesting forms, almost bewildering in their singular botanical features. Early in the season, the chief attraction centred on the evanescent annuals, which were scattered in great profusion over every bare knoll, in rock crevices, or under the scant shelter of the dull colored desert shrubbery. Largely represented among these is the genus *Phacelia*, including *P. Fremontii* Torr. (No. 177), whose showy spikes continue to unfold a succession of blossoms for four weeks or more. Hardly less showy is the *Phacelia crassifolia* Torr. (No. 182), with flowers of an intense blue shade, thickly scattered over gypseous clay knolls. This latter species frequently becomes dwarfed in exposed places, and spreads out in the form of purple patches over the bare soil.

In rock crevices we find the delicate *P. micrantha* (No. 181) associated with *P. rotundifolia* (No. 183), while later in the season, *P. crenulata* Torr. (No. 180), *P. curvipes* n. sp.? (No. 179), and the biennial *P. Palmeri* Torr. (No. 176), keep up the series. Hardly inferior to the above noted omnipresent forms of early spring vegetation, must be reckoned the different species of *Gilia*, which, though generally less showy, vie with them in variety and abundance. These latter include, besides the widely distributed and very variable *Gilia inconspicua* Dougl. (No. 199), the rarer

forms of *G. leptomeria* Gray (No. 197), *G. demissa* Gray (No. 196), *G. Bigelovii* Gray (No. 189), *G. flocosa* Gray (No. 192), *G. polycladon* Torr. (No. 191), *G. setosissima* Gray (No. 190), and a very delicate species with light yellow flowers, looking like flax, *G. filiformis* n. sp. (No. 187).

Among other interesting dwarf forms characterizing the early spring flora, may be noted *Thysanocarpus curvipes* Hook., *Malvastrum exile* Gray, *Lupinus Sileri* Watson, *Actinolepis Wallacei* Gray, *Actinolepis lanosa* Gray, *Syntrichopappus Fremontii* Gray, *Layia glandulosa* H. & A., *Styloclyne micropoides* Gray, *Nemacladus ramosissimus* Nutt., *Nama demissa* Gray, *Pterostegia drymarioides* F. & M.

Somewhat later in the season, as we shall have occasion to note farther on, a different class of annuals, largely represented by Eriogoneæ and Boragineæ, come forward to continue the series of evanescent forms.

Of perennial plants the early spring gave abundant promise, in the opening leaf and developing bud, of many strange forms. Among these the first to attract attention is a very common bushy shrub, with small inconspicuous flowers, crowded along the slender branches, almost hidden from view in the densely fasciculate leaves. This, which is readily recognized in its habit and peculiar peach-leaf odor, as belonging to the *Amygdaleæ* group of *Rosaceæ*, was characterized by Dr. Torrey in "Plantæ Fremontianæ" (fig. 10), from imperfect material under the name of *Emplectocladus fasciculatus* Torr. The more complete material now collected shows it to be not generically distinct from *Prunus*, being indeed closely allied to the *Prunus minutiflora* Engel.; it has accordingly been reduced by Prof. Gray to a section of *Prunus*, viz.: *P. (Emplectocladus) fasciculata* Gray (No. 56). By the inhabitants of the country it is known under the appropriate name of "wild almond," its small fruit, though bitter, being occasionally eaten. Among other early flowering shrubs of this district, may be enumerated *Rhus aromatica* Ait., and one of the numerous forms of the variable *Amelanchier Canadensis* T. & G. Quite commonly met with in deep sandstone ravines and on rocky slopes is the singular one-leaved ash, *Fraxinus anomala* Torr. (No. 210). This forms a clumpy bush eight to twelve feet in height, with bright green foliage, set off later in the season by pendent fascicles of fruit, of which the separate seeds are not unfrequently

3-angled. From the mature seed somewhat copiously collected, it is to be hoped that this singular species may be introduced into our gardens.

Of early bulbous plants *Androstephium breviflorum* Watson (No. 223) is quite common on all gravelly hills, succeeded somewhat later in the season by *Milla capitata* (No. 256), which latter exhibits an equally well-marked corona subtending the stamens, thus apparently invalidating the distinctions which have been relied on for separating the allied genera of *Millece*.

Early in May, *Chlochoortus flexuosus* Watson (No. 254) is conspicuous on hill-sides, with its showy tulip-like blossoms, which, on account of its prolonged branching flower stem, continues to flower for a longer period than most species of this attractive genus. The general Indian name of "*Sego*" is applied indiscriminately to all the edible bulbs of this region. Apparently quite out of place in this arid climate, we notice quite frequently on the perpendicular face of moist sandstone rocks, *Adiantum*, *Capillus venosis* L. (No. 262). Still more interesting is a common fern growing in dry rock crevices, resembling *Cheilanthes*, which Prof. Eaton on a critical examination determines to be a new species of *Notholaena* characterized by him as *N. Parryi* n. sp. (See appendix No. 263).

With the disappearance of late spring frosts, which frequently continue to the latter part of April, and occasionally as late as early May, the intense heat of the lengthening days, rarely obscured by clouds, or tempered by showers, brings forward a rapid development of the more characteristic forms of vegetation. By May 1st orchards had mostly dropped their blossoms; the fruit of the apricot and almond were developing, and strawberries beginning to ripen, giving to fields and gardens a summer aspect. In the open country an analogous feature is brought to view in the native vegetation. We accordingly note the appearance of several species of *Enothera*, conspicuous among which is a large yellow-flowered one, which being undescribed, I take pleasure in dedicating to my esteemed friend, J. E. Johnson, Esq., as *Enothera Johnsonii* n. sp. (See appendix No. 64). Mr. Johnson, who has had this plant for many years in his garden, called my attention to the regularity and suddenness of its opening, from fifteen to twenty minutes after sunsét. This opening process, as frequently observed by both of us, is accomplished by a shrinking

downward of the valvular calyx, the accumulated tension at a certain point suddenly releasing the segments from below upwards, which, becoming reflexed, allows the closely-confined convolute corolla to unfold visibly, its petals expanding in about thirty seconds, to a horizontal position. Quite constantly, just at this time, a small bee, apparently on the watch, darts in and loads itself with the stringy, adhesive pollen, to be carried, probably, to another flower. Generally, soon after, another bee on the same quest lands on the same flower, and finding the pollen gone, travels quickly over the stigmatic arms and soon flies away. This process frequently repeated ensures cross-fertilization.

Other *Ænotheræ* include a large white-flowered variety of the polymorphous *Æ. albicaulis* (No. 63); as a rarity we also meet with the very neat *Æ. primiveris* Gray (No. 65).

Of the group belonging to the *Chylisma* section, we have three well-marked forms represented. Of these, Nos. 73-74 are referred by Mr. Watson to *Ænothera brevipes* Gray; both have yellow flowers, of which those of No. 73 are most conspicuous. No. 74 is distinguished by a more branching habit, smaller light-yellow flowers, longer pedicels, and more conspicuous pinnatisect radical leaves. A third species of this section is characterized by Mr. Watson as *Ænothera Parryi* n. sp. (See appendix No. 72). This latter is of a singularly graceful habit, generally much branched, its prolonged spike of small yellow flowers being succeeded by distinctly clavate capsules, curving upwards from a slender divaricate pedicel. Quite constantly associated with this latter species, occupying dry gypseous clay knolls, is a very neat and showy *Mentzelia* (No. 78). This, though closely allied to the common *M. multiflora* Nutt., seems to present characters sufficient to distinguish it as a new species. Observing the two growing often side by side, the differences in habit, time of flowering and floral characters seem sufficiently distinct, nor were there any intermediate forms noticed. In the meantime it may be well to wait for a more full revision of this genus before venturing to add to the number of doubtful species.

Common at this season upon all sandstone or gravelly knolls, is the charming *Dalea Johnsoni* Watson (No. 40), with its deep indigo blue spikes. Now also comes forward *Coleogyne ramosissima* Torr. (No. 57), its dull green foliage being relieved by a profusion of light-yellow blossoms. *Aster tortifolius* Gray (No. 91),

with its large pale-blue heads, adds an unwonted brilliancy to the clefts of dark basaltic rocks. *Audibertia incana* Benth. (No. 159) is conspicuous along the line of dry ravines, with its dense blue spikes, and silvery foliage, exhaling a most pungent perfume. Other varieties include *Lepidium Fremontii* Watson, *Hymenoclea salsola* T. & G., *Franseria dumosa* Gray, *Salazaria Mexicana* Torr., *Lycium Torreyi* Gray.

Not least among the attractions of this flowering season are the Cacti, which include *Opuntia rutilla* Nutt., presenting a perfect mass of delicate pink rosettes, set in a bed of spines. *Cereus Engelmanni* Parry exhibits flowers of a deeper purple shade, which are succeeded by a delicious fruit, when it can be safely extracted from its thorny envelope. *Mammillaria phelosperma* Engel., or "the fish-hook cactus," is found as a rarity in rocky clefts, at this season adorned with its bright red fruit. On all gravelly knolls in this section a common arborescent *Opuntia* is met with (*O. Echinocarpa* Engel.). This species has an inconspicuous yellowish green flower nearly buried in a mass of barbed spines; otherwise its usually repulsive features are partly utilized by birds, who find in their spiny recesses, nesting places secure from the attack of snakes.

Chenopodiaceæ are everywhere largely represented by the following, viz., *Atriplex expansa* Watson, *A. confertifolia* Watson, *A. Nuttallii* Watson, *A. canescens* Watson, *Kochia Americana* Watson, *Suaeda diffusa* Watson, *Eurotia lanata* Moquin, and *Grayia polygalvides* H. & A., the latter with much more graceful foliage than noticed farther north, almost reconciles one to the imposition of this honored botanical name to a "grease wood."

The undergrowth comprises quite a number of singular *Cichoraceous Compositeæ*, including *Malacothrix Coulteri* Gray, *M. Torreyi* Gray, *Rafinesquia Neo-Mexicana* Gray, *Calycoseris Wrightii* Gray, *Microseris macrochaeta* Gray, *M. linearifolia* Gray, *Stephanomeria Thurberi* Gray, *S. exigua* Nutt., *Lygodesmia exigua* Gray. To these must be added as especially worthy of notice, the charming *Glyptopleura setulosa* Gray (No. 129), with its pure white blossoms, and cut fringed leaves, pressed close to the ground. This growing abundantly everywhere on gravelly soil, or dry bottom land, presents a succession of flowers opening in bright sunshine. Not unfrequently on gravelly slopes we meet with the rare *Compositeæ*, *Monoptilon bellidiformis* Gray (No. 100), heretofore only known

from a single Fremontian specimen. The large class of annual and perennial *Eriogonae* come forward in the latter part of May, allusion to which must be deferred to a succeeding paper, together with some more detailed notices of excursions to the higher mountains and alpine districts, south and west of St. George.

NOTE. The numbers affixed to species in the foregoing paper, correspond to the numbered sets, in the distributed collection.

THE COLOSSAL CEPHALOPODS OF THE NORTH ATLANTIC.

BY PROF. A. E. VERRILL.

In a former article published in the *NATURALIST* (vol. viii, p. 167, March, 1874) the writer gave a brief account of several gigantic cuttle-fishes, or "squids," which have been observed or captured at or near Newfoundland,¹ and in an earlier volume (vii, p. 91) Dr. Packard gave an account of previous captures of similar huge Cephalopods on the coasts of North America and Europe. The existence of several distinct species of these colossal ten-armed Cephalopods has been satisfactorily demonstrated in the various papers that have been written upon the subject both in Europe and America. Most of the specimens hitherto obtained have been taken in the Atlantic Ocean, but at least one gigantic species (*Enoploteuthis unguiculata*) inhabits the Indian Ocean, while the origin of some of the described specimens is not known.

In this article I propose to describe portions of five different specimens of these monsters, now in my possession, and also to give some account of five other specimens that have been observed on our side of the Atlantic.

The five specimens that I have been able to study evidently belong to two quite distinct species, both of which belong to the genus *Architeuthis* of Steenstrup (or *Megaloteuthis* of Kent). The largest of these is represented only by the jaws of two

¹ See also an article on this subject by the writer, in the "*American Journal of Science*," vol. vii, p. 158, Feb., 1874; and letters from Mr. Alexander Murray in the *NATURALIST*, vol. 8, p. 120, Feb., 1874.

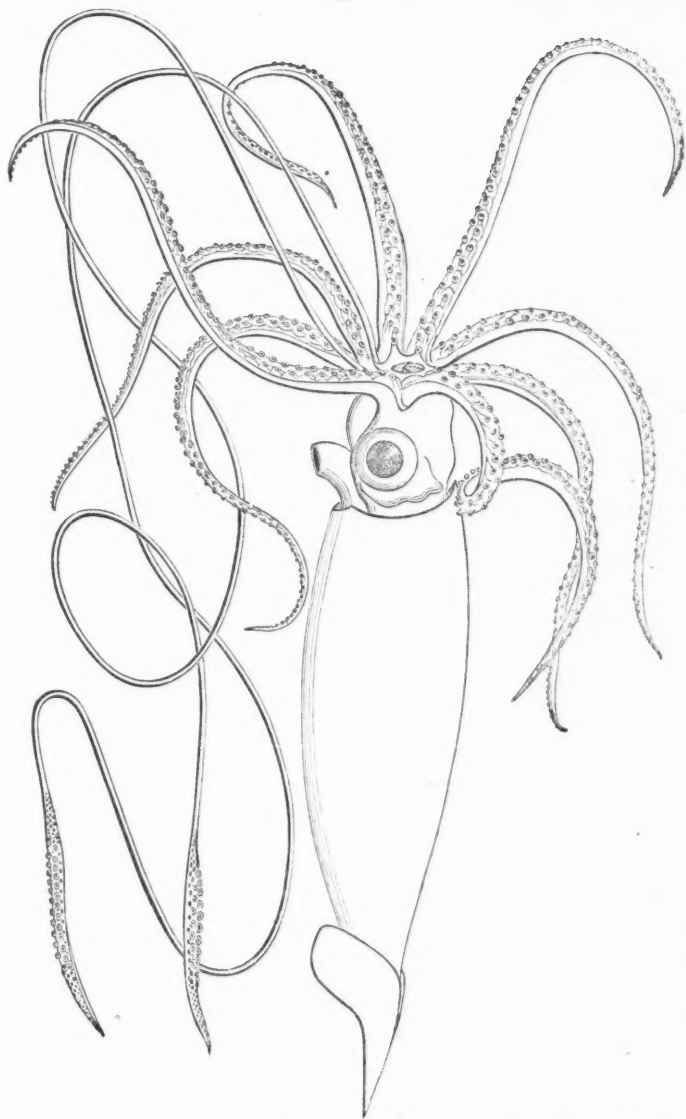
specimens, one of which (No. 1 in my former articles) was found floating at the Banks of Newfoundland, and the other (which we will designate as No. 10) was taken from the stomach of a sperm whale. The upper jaw of the latter was imperfectly figured by Dr. Packard in his article referred to above, and it is the largest jaw yet known. These belong to an apparently undescribed species, which I propose to name *Architeuthis princeps*,² and shall describe more fully farther on. It is readily distinguished from the following by the blacker, thicker, stronger and more incurved beaks, and especially by the large and very prominent tooth or projection, arising from the margin of the cutting edges of the alæ, on the lower jaw. The body appears to have been relatively much longer than in the following species.

The second species, which I consider identical with the *Architeuthis monachus* of Steenstrup, is more fully represented by parts of three individuals, and seems to be the species most commonly met with on the coasts of Newfoundland and Labrador.

The most complete specimen (fig. 1) that has ever come under scientific observation was captured in November, 1873, at Logie Bay, near St. John's, Newfoundland. It became entangled in herring-nets and was secured by the fishermen with some difficulty and only after quite a struggle, during which its head was badly mutilated and severed from the body, and the eyes, most of the siphon-tube, and the front edge of the mantle were destroyed. Fortunately this specimen was secured by the Rev. M. Harvey of St. John's. After it had been photographed and measured, he attempted to preserve it entire in brine, but this was found to be ineffectual, and after decomposition had begun to destroy some of the most perishable parts, he took it from the brine and, dividing it into several portions, preserved such parts as were still undecomposed in strong alcohol. These various portions are now in my possession, and with the photographs have enabled me to present a restoration, believed to be quite accurate, of the entire creature (fig. 1). In this figure the eyes, ears, siphon-tube, and front edge of the mantle have been restored from a small squid (*Loligo pallida*) to which this gigantic species seems to be nearly

² This species was named and characterized in a communication made to the Connecticut Academy of Sciences, Nov. 18, 1874, and will be described in greater detail in its Transactions.

Fig. 1.



Architeuthis monachus (No. 5), one twenty-second natural size, from Logie Bay, N. F.
(23)

allied in many respects. The other parts have been drawn directly from the photographs and specimens.³

Mr. Harvey has published popular accounts of this specimen and the previously captured arm of a still larger one, in an interesting article in the *Maritime Monthly Magazine* of St. John, N. B., for March, 1874, and in several newspapers.⁴ These articles, and extracts from them, have been widely copied in the newspapers and magazines. To him we are, therefore, mainly indebted for these latest and most important additions to our knowledge of these remarkable animals. The preserved parts of this specimen (No. 5) which I have been able to examine are as follows: the anterior part of the head, with the bases of the arms, the beak, lingual ribbon, etc.; the eight shorter arms, but without the suckers, which dropped off in the brine, and are now represented only by the strong marginal rings; the two long tentacular arms, which are well preserved, with all the suckers in place; the tail; portions of the "pen" or internal shell; the ink-bag and pieces of the body.

Since this is the most complete specimen hitherto obtained, it will be first described as a standard for comparison with the other less complete ones.

The general appearance and form of this species,⁵ which appears

³The figure was originally made, from the photographs only, by Mr. P. Roetter, of the Museum of Comparative Zoology, but after the arrival of the specimens it had to be altered in many parts. These necessary changes were made by the writer, after a careful study of the parts preserved, in comparison with the photographs and original measurements.

⁴Acknowledgments are also due to Mr. Alexander Murray, Provincial Geologist, who coöperated with Mr. Harvey in the examination and preservation of these specimens, and who has also written some of the accounts of them that have been published. See the *AMERICAN NATURALIST*, vol. viii, p. 122, February, 1874; "*American Journal of Science*," vol. vii, p. 160; and "*Nature*," vol. ix, p. 322, February 26, 1874.

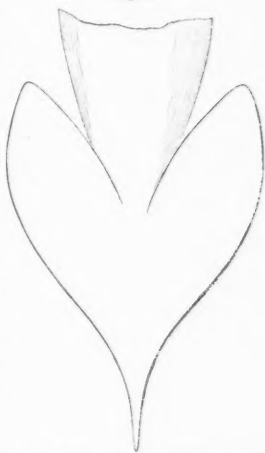
⁵Mr. W. Saville Kent, from the descriptions and photographs of this species, has seen fit to give it new generic and specific names, viz.: *Megaloteuthis Harveyi*, according to notices of his communication made to the Zoological Society of London, March 3, 1874, in "*Nature*" (vol. ix, p. 375, March 12, and p. 403, March 19). But as no sufficient reason was given for doing so, in the notices referred to, and as his original communication appears not to have been published yet (at least it has not been received here) I am unable to judge what his actual reasons for this proceeding may be.

My identification is based on a comparison of the jaws with the jaws of *A. monachus*, well figured and described by Steenstrup. Their agreement is very close in nearly all respects, but the beak of the lower jaw is a little more divergent in Steenstrup's figure. His specimen was a little larger than the one here described and was taken from a specimen cast ashore in 1853. So that Mr. Kent was probably unaware of that specimen when he said ("*Nature*," ix, p. 403) that *A. monachus* "was instituted for the reception of two gigantic Cephalopods, cast on the shores of Jutland in the years 1639 and 1790, and of which popular record alone remains."

His statement that *Architeuthis dux* Steenstrup is known from the beak alone is

to be the *Architeuthis monachus* of Steenstrup, is well shown by fig. 1. From the great size of the large suckers on the long arms, I judge it to be a male. The body was relatively stout, and according to the statement of Mr. Harvey, it was, when fresh, about seven feet long and five and one-half feet in circumference. The portion of the body shown in the photograph appears to have been only about five and one-half feet long, and is badly mutilated anteriorly, so that it is possible that Mr. Harvey has allowed too much for the missing parts. In restoring the figure here presented, the length of the body was reckoned at seven feet, and reduced twenty-two times. The "tail" or caudal fin (fig. 2) is said by Mr. Harvey to have been twenty-two inches across, but the preserved specimen is considerably smaller, owing, undoubtedly, to shrinkage in the brine and alcohol. It is remarkable for its peculiar spear-shaped or broad sagitate form. The posterior termination is unusually acute and the lateral lobes extend forward considerably beyond their insertion. In the preserved specimen the total length, from the anterior end of the lateral lobes to the tip of the tail, is twenty-three inches; from the lateral insertions to the tip nineteen inches; from the dorsal insertion thirteen and five-tenths inches; total breadth about fifteen inches; width of lateral lobes six inches. The body, as seen in the photograph, is badly collapsed and it must be a matter of great difficulty to obtain the true diameter of the body in any of these large squids, owing to the

Fig. 2.

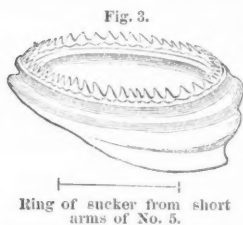


Tail of No. 5, one-tenth nat. size.

erroneous, for Steenstrup, Harting, and Dr. Packard, in their articles on this subject, all state that the suckers, parts of the arms, and the internal shell or pen were preserved, and they have been figured by Prof. Steenstrup; Harting has also given a figure of the lower jaw. Steenstrup mentions having the arm-hooks (Tandvæbningen), which would indicate a genus distinct from our species.

Should the *Architeuthis dux* prove to belong to a genus distinct from this and all known genera, it might perhaps be taken as the type of *Architeuthis*, and in that case the generic name given by Kent could be retained, and the two species here described would then be called *Megalogeuthis monachus* and *M. princeps*, if my identification of the former species be correct.

fact that they collapse greatly when taken from the water. The circumference of the body given above may, therefore, be considerably too small. In that case the figure represents the body more slender than it should be. The head was probably at least equal to one-fifth the length of the body. The eight shorter arms, when fresh, were, according to Mr. Harvey's measurements, six feet long and all of equal length, but those of the different pairs were respectively ten, nine, eight and seven inches in circumference. In alcohol they have shrunk considerably, both in length and diameter. They are three-cornered or triquetral in form and taper very gradually to slender acute tips. Their inner faces are occupied by two alternating rows of large obliquely campanulate suckers, with contracted apertures surrounded by broad, oblique, marginal rings, armed with strong, acute teeth

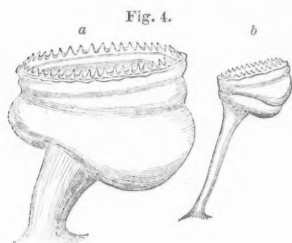


around their entire circumference, but largest and most oblique on the outside (fig. 3). These suckers gradually diminish in size to the tips of the arms, where they become very small, but are all similar in form and structure. The largest of these suckers are said by Mr. Harvey to have been about an inch in diameter, when fresh. The largest of their marginal rings in my possession are .65 of an inch in diameter, at the serrated edge, and .75 beneath. The rings of the smaller suckers are more oblique and more contracted at the aperture, with the teeth more inclined inward, those on the outside margin being largest. The two long tentacular arms are remarkable for their slenderness and great length when compared with the length of the body. Mr. Harvey states that they were each 24 feet long and 2.75 inches in circumference when fresh. In the brine and alcohol they have shrunk greatly, and now measure only 13.5 feet in length, while the circumference of the slender portion varies from 2.25 to 3.25 inches. These arms were evidently highly contractile, like those of many small species, and consequently the length and diameter would vary greatly according to the state of contraction or relaxation. The length given (24 feet) probably represents the extreme length in an extended or flaccid condition, such as usually occurs in these animals soon after death. The slender portion is three-cornered or trique-

tral in form, with the outer angle round, the sides slightly concave, the marginal angles prominent, and the inner face a little convex and generally smooth, except toward the end, where it begins to enlarge. Although so slender, these arms are very strong and elastic. The terminal portion, bearing the suckers, is 30 inches in length and expands gradually to the middle, where it is 4.5 to 5 inches in circumference (6 inches when fresh), and 1.5 to 1.6 across the inner face. The sucker-bearing portion may be divided into three parts. The first region occupies about 7 inches, in which the arm is triquetral, with margined lateral angles, and gradually increases up to the maximum size, the inner face being convex and bearing about forty irregularly scattered, small, flattened, saucer-shaped suckers, attached by very short pedicels, and so placed in depressions as to rise but little above the general surface. These suckers have narrow marginal rings, with the thin edges nearly smooth, or minutely denticulate, and .10 to .12 of an inch in diameter, surrounded by a thick and prominent marginal membrane. These suckers are at first distantly scattered, but become more crowded as the arm increases in breadth, until they form five or six very irregular rows, covering the whole width of the inner face, which becomes here 1.6 inches broad. Scattered among these suckers are about as many low, broad, conical, smooth, callous verrucae, or wart-like prominences, rising above the general surface, their central elevation corresponding in form and size to the apertures of the adjacent suckers. These, without doubt, are intended to furnish secure points of adhesion for the corresponding suckers of the opposite arm, so that, as in some other genera, these two arms can be fastened together at this wrist-like portion, and thus they can be used unitedly. By this means they must become far more efficient organs for capturing their prey than if used separately. Between these smooth suckers and the rows of large ones there is a cluster of about a dozen small suckers, with serrate margins, mostly less than a quarter of an inch in diameter, attached by slender pedicels, and with an oblique marginal ring, strongly and sharply serrate on the outer margin.

The second division of the sucker-bearing part of the arm succeeds the small suckers. Here the arm is well rounded on the back and flattened on the face, where it bears two alternating rows of very large serrate suckers, and an outer row of small ones on each side, alternating with the large ones. The inner edge is bor-

dered by a rather broad, regularly scalloped, marginal membrane, the scallops corresponding to the large suckers. On the other edge there is a narrower and thinner membrane, which runs all the way to the tip of the arm, just outside the suckers. In one of the rows of large suckers there are eleven, and in the other ten, above half an inch in diameter, but each row has at either end one or two smaller ones, from a half an inch to a quarter of an inch in



Suckers from long arms of No. 5.
Natural size.

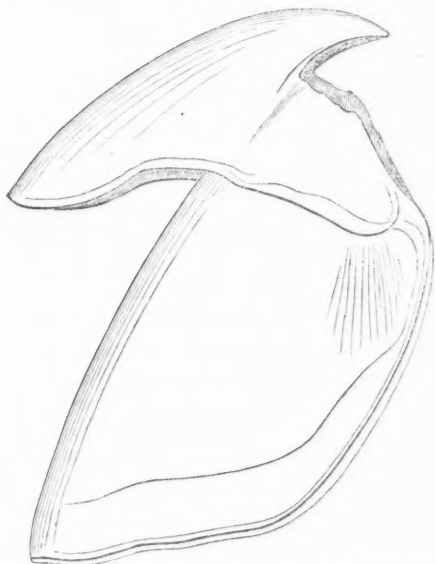
diameter, so that either twelve or thirteen might be counted as belonging to the rows of large suckers. The largest of these (fig. 4, *a*) are from 1 to 1.15 inches in diameter at the margin. These are attached by strong, though slender, pedicels, so that their margins are elevated about an inch above the surface of the arm. Each one is situated in the centre of a pentagonal depressed area, about an inch across, bounded by ridges, which alternate regularly, and interlock on the two sides, so as to form a zigzag line along the middle of the arm. These large suckers are campanulate, and somewhat oblique; the marginal ring is strong, and sharply serrate all around. The small marginal suckers (fig. 4, *b*) are similar in structure, but more oblique, and mostly only .3 to .4 of an inch in diameter; they are attached by much longer and more slender pedicels, and their marginal teeth are relatively larger and more incurved, especially on the outer margin. By reason of their longer pedicels they rise to the same height as the large ones. The third, or terminal division of the arm, gradually becomes much compressed laterally, and tapers regularly to the tip, which is flat, blunt, and slightly incurved. Just beyond the large suckers, where this region begins, the circumference is 3.5 inches. The face is narrow and bears a large number of small serrate and pedicellate suckers, arranged in four regular alternating rows, and gradually diminishing in size to the tip of the arm, where the rows expand into a small cluster. These suckers are much like the marginal ones of the previous division, and at first are about .25 of an inch in diameter, but decrease to about .10 of an inch near the tip of the arm. The lateral membrane or fold of skin, of the preceding divisions, recedes farther

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from the margin near the commencement of this division, and gradually passes around to the back side, where it forms a broad, thick wing or keel, extending to the tip. The color, where preserved, is pale reddish, with thickly scattered small spots of brownish red.

The form of the jaws of this specimen is well shown by figs. 5 and 6. When in place, these jaws constitute a powerful beak, looking something like that of a parrot or hawk, except that the

Fig. 5.



Upper jaw of *Architeuthis monachus*, No. 5. Natural size.

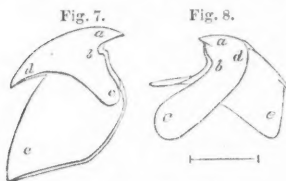
upper jaw shuts into the lower, instead of the reverse, as in birds. In life the great spaces behind and between the large, thin, lateral and posterior processes and expansions are filled with firm muscles and cartilage, which support and give great strength to the beak. The color is dark brown, becoming almost black toward the tip, where its substance is thicker and firmer, and smoothly polished externally. The upper jaw (fig. 5) measures 3·85 inches in total length; 1 inch in greatest breadth; and 2·50 from front to back.

The lower jaw (fig. 6) is 3 inches long; 2.75 broad; and 2.65 from front to back.

Fig. 6.

Lower jaw of *Architeuthis monachus*, No. 5. Natural size.

The small squids of our coast have a very similar pair of jaws. Those of *Loligo pallida* (figs. 7, 8), are here figured, twice the

Jaws of *Loligo pallida*.⁶

natural size, for comparison and to explain the terms used in describing the large jaws. The lower jaws of the large squids are more characteristic than the upper ones. In the one under consideration the points to be particularly noticed are, first, the narrow, but decided notch at the base of the nearly straight cutting edge; second, the broad, low, rounded projection or tooth on the anterior edge of the alæ; third, the angle between the edges of the alæ and the rostrum is nearly a right angle, and the tip of the jaw is slightly incurved.

⁶ Figure 7, upper jaw, and 8, lower jaw of *Loligo pallida* V., enlarged two diameters; *a*, the rostrum or beak; *ab*, the cutting edge, with a notch at *b*; *bc*, the anterior edge of the alæ or wings; *d*, the frontal lamina in the upper jaw, or chin-portion (*mentum*) in the lower jaw; *e*, the palatine lamina in the upper jaw, or gular lamina in the lower jaw.

The most remarkable anatomical character observed in this specimen is found in the form and arrangement of the teeth on the "lingual ribbon," or *odontophore*, for in this respect it differs widely from all other known Cephalopods.

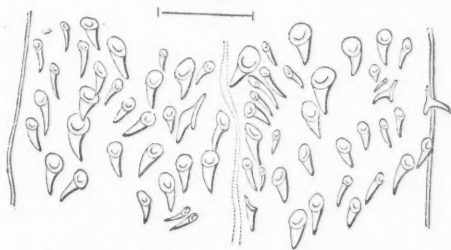
The ordinary squids and cuttle-fishes all have these teeth arranged in seven regular longitudinal rows; those of the three middle rows being generally two or three-pronged, as in *Loligo*

Fig. 9.

Teeth of *Loligo pallida*, much enlarged.

pallida (fig. 9), while the lateral rows have long, simple, fang-like teeth. But in this species (fig. 10), the teeth are very irregularly scattered over the surface of the broad thin membrane, and it is difficult to trace the rows, if such they can be called, for the arrangement seems to be somewhat in irregular quincunx. The number of rows, however, cannot be less than twenty. These

Fig. 10.

Lingual teeth of *Architeuthis monachus*, No. 5.

teeth are all simple, but vary considerably in size and form. They are all attached by a more or less rounded, flattened base, and all are considerably curved; some are broad and tapering; others are slender and acute; but the different forms and sizes are irregularly intermingled across the whole breadth of the membrane.⁷

⁷ Irregular granules of silica are scattered in great numbers over the membrane among the teeth, and similar grains are embedded in the membrane lining the mouth.

This peculiar type of dentition must be regarded as an extremely generalized one. Whether it be also an embryonic type, or one that prevailed in ancient geological periods must be left for future determination. The character of these teeth indicates that this genus should hold low rank among the related genera. This conclusion is confirmed both by the structure of the caudal-fin, or tail, which somewhat resembles the early condition of the fins in the young *Loligo*, soon after it hatches, and by the form and structure of the internal shell or "pen," which is also very simple in structure, and but little differentiated or specialized.

The portions of the pen in my possession belong mostly to the two ends, with fragments from the middle region, so that although neither the actual length nor the greatest breadth can be given, we can yet judge very well what its general form and character must have been. It was a broad and extremely thin structure, of a yellowish brown color, and translucent. Its anterior portion resembles that of *Loligo*, but its posterior termination is entirely different, for instead of having a regular lanceolate form, tapering to a point at the posterior end, as in *Loligo*, it expands and thins out toward the posterior end, which is very broadly rounded or irregularly truncate, fading out insensibly both at the edges and end into soft membrane. The anterior end, for about an inch and a half, was rapidly narrowed to a pen-like point, as in *Loligo*; from this portion backward the width gradually increases from 1.2 inches to 5 inches, at a point 25 inches from the end, where our specimen is broken off; at this place the marginal strips are wanting, but the width is 5 inches between the lateral midribs, which were, perhaps, half an inch from the margin. Along the centre of the shell, there is a strong, raised, rounded midrib, which fades out a short distance from the posterior end, but is very conspicuous in the middle and anterior sections. On each side of the midrib is a lateral rib of smaller size. These at first diverge rapidly from the central one, and then run along nearly parallel with the outer margin and about .4 of an inch from it, but beyond 11 inches from the point the margins are torn off. Like the midrib the lateral ribs gradually fade out before reaching the posterior end; near the place where they finally disappear, they are about 6 inches apart.

From the above description it will be seen that the most important and most characteristic features of this species, or rather o

the *genus* to which it belongs, are to be found in the *lingual dentition*, in the *internal shell*, in the *form of the caudal-fins*, and in the cluster of small suckers and tubercles on the long arms. As already stated, the first three of these peculiarities indicate a low, or generalized structure, and therefore a low rank in our system of classification, unless it should be found to have some other characters not yet known and of greater importance, which might outweigh those here given. It will appear, therefore, that this genus of huge squids should be classed below *Loligo*, which, in its turn, would go below *Ommastrephes*, to which genus the common small squids of our northern coasts belong, for the latter genus has distinct eyelids, which are not found in *Loligo*, and the internal shell is also more specialized.

The pen of our *Architeuthis* seems to resemble that of the ancient genus *Teudopsis*, found fossil in the Jurassic formations, and contemporaneous with the huge marine saurians, *Icthyosaurus*, *Plesiosaurus*, etc., the "sea-serpents" of those ancient seas. May there not also be huge marine saurians still living in the North Atlantic, in company with the giant squids, but not yet known to naturalists?

Such a belief seems quite reasonable when we consider how many species of great marine animals, both among Cephalopods and Cetaceans, are still known only from single specimens, or even mere fragments, generally obtained only by chance. The specimen above described, is, however, not the only specimen of its kind that has been observed on the American coast.

I have received through Professor Baird, of the Smithsonian Institution, a pair of jaws and two large suckers of the long arms, which were taken from a specimen (No. 4), cast ashore in Bonavista Bay, Newfoundland. These jaws agree precisely in form and size with those described above, so that the size of these two individuals must have been about the same. The suckers (fig. 11), had been dried, and have lost their true form, but the marginal rings are perfect, and only .92 of an inch in diameter, and though somewhat smaller than in the specimen just described, they have the same kind of denticulation around the margin. Their smaller size may indicate that the specimen was a female, but they may not have been the largest of those on the arm.

Fig. 11.



Sucker of long arm of *Architeuthis monachus*, No. 4. Natural size.

Accounts of an attack made upon two men by another specimen, in Conception Bay, Oct. 27, 1873, have been published in the *NATURALIST*,⁸ and in many other magazines, as well as in the newspapers. In the encounter the monster lost two of his arms by amputation with a hatchet. A portion of one of these arms, measuring nineteen feet in length, was preserved by Rev. M. Harvey and Mr. Alexander Murray for the museum at St. John's, Newfoundland. It has been photographed, and cuts copied from the photograph have been published in some of the English magazines.⁹

It is stated that six feet of this arm had been destroyed before it was preserved, and the captors estimated that they left from 6 to 10 feet attached to the creature, which would make the total length between 31 and 35 feet. According to Mr. Murray the portion preserved measured but 17 feet in length, when he examined it, Oct. 31, 1873, after it had been a few days in strong brine; the circumference of the slender portion was 3.5 to 4 inches; of the enlarged sucker-bearing part, 6 inches; length of the part bearing suckers, 30 inches; diameter of largest suckers, 1.25 inches. Calculating from the photograph, the portion bearing the larger suckers was about 18 inches in length, and about 2.4 inches broad, across the face; distance between attachments of large suckers, 1.68; outside diameter of larger suckers, 1.16 to 1.28; inside diameter, .74 to 1 inch; diameter of small suckers of the outside rows, .40 to .48 of an inch. Comparing all these dimensions with those of the Logie Bay specimen, and calculating the proportions as nearly as possible, it follows that this specimen was very nearly one-third larger than the latter, but the large suckers appear to have been relatively smaller, for they were hardly one-twelfth larger than in the Logie Bay specimen. As the relative size of the large suckers is a good sexual character among squids, it is probable that this individual was a *female*. In form, proportions and structure, it agrees very closely with the specimen first described, and therefore I do not hesitate to refer it to the same species. The lack of denticles on the margins of the large suckers is probably due to accidental injury, either before or

⁸ Vol. viii, No. 2, p. 120, February, 1874, in a letter from Mr. Alexander Murray.

⁹ See "Annals and Magazine of Natural History," vol. xiii, p. 68; and "The Field," Dec. 13, 1873. The central line of this photograph is reduced four and a quarter times, while the front part is reduced about four times.

after death,¹⁰ but this may possibly be a sexual character. The fishermen estimated the body of this individual to have been about 60 feet in length and 5 feet in diameter, but if the above proportions be correct, as I believe, then the body could not have been more than about 10 feet long, and 2.5 feet in diameter, and the long arms should have been about 32 feet in length. Allowing 2 feet for the head, the total length would, therefore, be 44 feet.

Another specimen (No. 3), probably of the same species, and similar in size to the last, was captured at Coombs' Cove, Newfoundland. The following account has been extracted from a newspaper article of which I do not know the precise date, forwarded to me by Professor Baird, together with a letter, dated June 15, 1873, from T. R. Bennett, Esq., of English Harbor, N. F., who states that he wrote the article, and that the measurements were made by him, and are perfectly reliable.

"Three days ago, there was quite a large squid ran almost ashore at Coombs' Cove, and some of the inhabitants secured it. The body measured 10 feet in length and was nearly as large round as a hog's head. One arm was about the size of a man's wrist, and measured 42 feet in length; the other arms were only 6 feet in length, but about 9 inches in diameter, very stout and strong. The skin and flesh were 2.25 inches thick, and reddish inside as well as out. The suction cups were all clustered together, near the extremity of the long arm, and each cup was surrounded by a serrated edge, almost like the teeth of a hand-saw. I presume it made use of this arm for a cable, and the cups for anchors, when it wanted to come to, as well as to secure its prey, for this individual, finding a heavy sea was driving it ashore, tail first, seized hold of a rock and moored itself quite safely until the men pulled it on shore."

It would appear from this description, that one of the long arms had been lost before the capture. The large diameter of the short arms, compared with their length, and with the size of the long arms, is the only point in which this specimen apparently differed essentially from those described above. Possibly the *circumference* was intended,¹¹ which would make the proportions agree well with those of the other specimens.

In a letter from Mr. Harvey, dated Dec. 10, 1873, he says that

¹⁰ The photograph shows that the suckers had been much injured, and only six of the larger ones remained.

¹¹ A similar mistake actually occurred in the description of the long arms, in the letter from Mr. Murray, published in the *AMERICAN NATURALIST* for February, 1873, p. 122, referred to above, but in that instance the error was very obvious.

the speaker of the House of Assembly stated to him that he had measured a specimen cast ashore in Fortune Bay, which was between 42 and 43 feet in length, the body and head together being between 12 and 13 feet, and the two long arms each 30 feet. This we may designate as No. 6.

Dr. Honeyman, Geologist of Nova Scotia, has published in a Halifax paper, a statement made to him by a gentleman who claims to have been present at the capture of another specimen (No. 7) in the Straits of Belle Isle, at West St. Modent, on the Labrador side. "It was lying peacefully in the water when it was provoked by the push of an oar. It looked fierce and ejected much water from its funnel; it did not seem to consider it necessary to discharge its sepia, as mollusca of this kind generally do, in order to cover their escape." * * * * "The length of its longest arm was 37 feet; the length of the body 15 feet; whole length 52 feet. The bill was very large. The suckers of its arms or feet, by which it lays hold, about 2 inches in diameter. The monster was cut up, salted, and barrelled for dog's meat." In this account the length given for the "body" evidently includes the head also. This creature was probably disabled, and perhaps nearly dead, when discovered at the surface, and this seems to have been the case with most, if not all, of the specimens hitherto seen living. Animals of this sort probably never float or lie quietly at the surface when in good health. The specimen last described (No. 7) may, possibly, have belonged to *A. princeps*, if the length of the body be correctly stated.

Mr. Harvey also refers to a statement made to him by a clergyman, Rev. M. Gabriel, that two specimens (Nos. 8 and 9), measuring respectively 40 and 45 feet in total length, were cast ashore at Lamaline, on the southern coast of Newfoundland, in the winter of 1870-71. These may also have been of the same species as those described above, all of which I now refer to *Architeuthis monachus* of Steenstrup.

NOTE.—Since the above has been in type, Mr. Kent's paper, referred to on page 24 has been received by the editors of the "American Journal of Science," and will be again noticed in our next article.

[To be continued.]

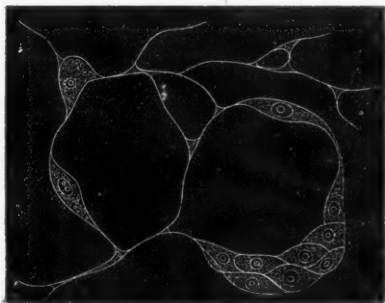
LIFE HISTORIES OF THE PROTOZOA.

BY A. S. PACKARD, JR.

IV. THE LABYRINTHULÆ.

WE would not pass over certain forms doubtfully referred to the Protozoa, by Cienkowski, the only one who has studied them, and placed by Hæckel near the Diatoms and Desmids, in his

Fig. 12.



Labyrinthula.

kingdom "Protista," but which may be provisionally located near the Rhizopods. These organisms were found by Cienkowski at Odessa beneath the seaweeds growing on the piles in the harbor. They are minute, orange-colored organisms, forming reticulated threads which enclose spindle-shaped nucleated bodies. Fig. 12, represents *Labyrinthula macrocystis*, highly magnified, with the single spindle-shaped bodies starting out from the mass on the left, and gliding over the "rope walk," or framework of threads. Cienkowski gives the following results of his investigations on the nature of these singular organisms, which we hope may be discovered in this country :

1. They present masses of cells which enclose a nucleus, and which increase in number by division ; they possess a certain degree of contractility, and now and then are covered with a cortical substance.

2. These cells exude a fibrous substance, which makes a stiff, tree-like network, forming a branching framework.

3. The cells leave the mass and glide in different directions along the framework to the periphery of the mass. The Labyrinthula cells can only continue their peregrinations when supported by this line of threads.

Development. The moving cells unite in a new mass and become cysts, in which each cell is surrounded by a hard covering, the whole being held together by a rind-like substance.

After some time four small granules are formed from each cyst, which most likely become young Labyrinthula cells.

He concludes that "these peculiar organisms bear no relation to any known group of beings of either of the organic kingdoms. They cannot be classed with the sponges, Rhizopoda, Gregarinæ, or ciliated Infusoria, or with the algæ or fungi."

LITERATURE.

Cienkowski. Ueber die Bau und Entwicklung der Labyrinthuleen. (Schultze's Archiv, 1867. Abstract in Quart. Journ. Micr. Science, 1867.)

V. THE FLAGELLATA.

As with the Amœba-stage of the lower Protozoa, so we have had anticipations of the Monads, as the Flagellata may be popularly styled, in the zoospores of the lower Protozoa and Monera. The monads in point of structure are scarcely more highly organized in their lowest forms than the spores of the algæ and the zoospores of the other Protozoa, for which they are often mistaken. They are exceedingly minute, oval bodies, with a nucleus and contractile vesicle and one or two long whip-like cilia, whence the term *Flagellata*.

The true monads have been studied by the late Professor H. J. Clark with more success than by any one else. *Monas termo* Ehr.? is much like single individuals of *Urella glauconia* Ehr.? (Fig. 13), though the body is shorter and more regularly oval. It is faint olive in color. The monads are provided with one or more flagella, or bristle-like cilia, situated in *M. termo* on the front near the beak-like prolongation of the body. In swimming the monad stretches out the flagellum, which "vibrates with an undulating, whirling motion, which is most especially observable at its tip, and produces by this mode of propulsion the peculiar rolling of the body, which at times lends so much grace to its movements as it glides

from place to place" (Clark). When the monad is fixed the flagellum is used to convey food to the mouth, which lies between the base of the flagellum and beak, or "lip," as Clark calls it. The food is thrown by a sudden jerk and with precision, directly against the mouth. "If acceptable for food, the flagellum presses its base down upon the morsel, and at the same time the lip is thrown back so as to disclose the mouth, and then bent over the particle as it sinks into the latter. When the lip has obtained a fair hold upon the food, the flagellum withdraws from its incumbent position and returns to its former rigid, watchful condition. The process of deglutition is then carried on by the help of the lip alone, which expands latterly until it completely overlies the particle. All this is done quite rapidly, in a few seconds, and then the food glides quickly into the depths of the body, and is enveloped in a digestive vacuole, whilst the lip assumes its usual conical shape and proportions."

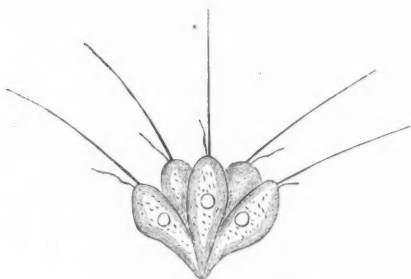
All the monads have a contractile vesicle. In *Monas termo*, Clark observes that it is "so large and conspicuous that its globular form may be readily seen, even through the greatest diameter of the body; and contracts so vigorously and abruptly, at the rate of six times a minute, that there seems to be a quite sensible shock over that side of the body in which it is embedded." The contractile vesicle is thought to represent the heart of the higher animals. The reproductive organ may possibly, says Clark, be represented in *Monas termo*, by a "very conspicuous, bright, highly refracting, colorless oil-like globule which is enclosed in a clear vesicle" called the nucleus. This and other monads live either free, or attached by a slender stalk. As an example of the compound or aggregated monads may be cited *Urella*

Fig. 13.



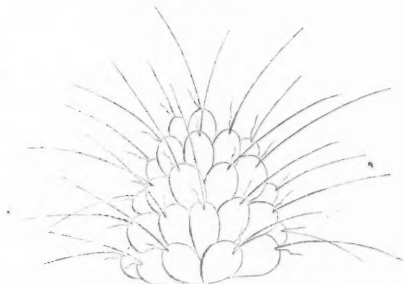
(Fig. 13), probably *glauconia* of Ehrenberg, of which an account, with accompanying figures, here reproduced, was published by Prof. A. H. Tuttle in the AMERICAN NATURALIST, vi, 286. Figs. 13, 14 and 15 represent two, five, and about forty monads of this species, magnified 1000 diameters. Fig. 16 is an ideal section through a colony of this monad. *Urella*, as Tuttle observes, "probably

Fig. 14.



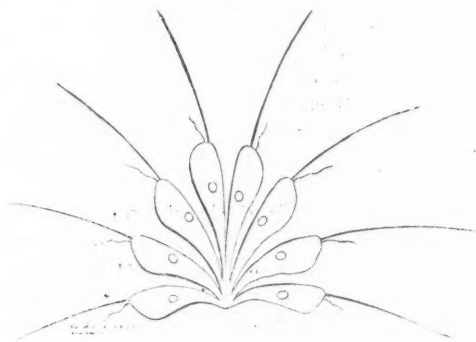
A group of five Monads (Urella).

Fig. 15.



A colony of about forty Monads (Urella).

Fig. 16.



Ideal section through a colony of Urellæ.

finds its nearest ally in Anthophysa, differing from that genus principally in being free swimming instead of fixed upon a stalk." The genera *Chlamydomonas* and *Colpodella* are represented at Fig. 20, B. A higher form than *Monas* is *Codosiga* (Fig. 17) in which the oval body is stalked and continued in front into a very high membranous bell-shaped collar. Other monads are certain human parasites; i.e., *Cercomonas urinarius*, *C. intestinalis* and *Trichomonas vaginalis*.

The second family of monads are the *Astasiæa*. Here belong *Astasia* and *Euglena* (Fig. 18). The former genus is somewhat amœba-like in the changes which it undergoes, its body, according to Clark, during its amœboid retroversions becoming "contorted into a shapeless, writhing mass." They have a conspicuous, red so-called "eye-spot." A similar organ occurs in the zoospores of some algæ.

The third family of Flagellata, the *Peridinea*, is represented by *Heteromastix*, *Dysteria*, *Pleuronema*, *Peridinium* and *Ceratium*. Clark observes that *Heteromastix* is a transitional form connecting the Flagellata with the Ciliata or true Infusoria. *Dysteria* is still nearer to the Infusoria. Clark describes it as a two-shelled infusorian, with the open space between the shells provided with "a row of closely set, large vibratile cilia," with one larger than the others, the true flagellum. After a careful description of this organism he concludes that "in all the organization of this animal there is nothing which is not strictly infusorian in character. The jaw-like bodies are not confined to this alone, for there are quite a number of others which possess a similar apparatus at or near the mouth. *Chilodon* has a complete circle of straight rods around the mouth. As for the pivot it is nothing but a kind of stem, such as exists on a larger scale in *Stentor*, or is more particularly specialized in the pedestals of *Epistylis*, *Zoothamnium*, or *Podophrya*; and as counter to what we see in these last, I would state that there are certain of the Vorticellians closely related to *Epistylis*, which have no stem whatever, and swim about as freely as *Dysteria*."

The Monads are divided into three families, thus characterized by Claus in his "Grundzuge der Zoologie:"

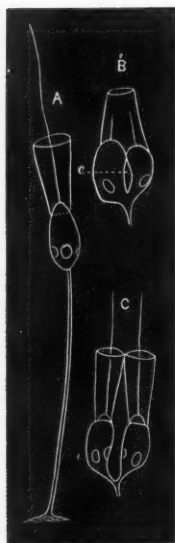
1. *Monadina*. Body small, rounded, naked or with a tough membrane; resembling the zoospores of algæ, etc.

2. *Astasiæa*. Body naked and changeable like the monads, only bearing flagella.

3. *Peridinea*. Body having, besides the flagellum, a row of cilia.

Development. The common form of reproduction is by simple self-division. Clark describes this as he observed it in *Codosiga pulcherrimus* (Fig. 17, A). The act requires forty minutes. The first sign of fission is a bulging out of the collar, which becomes still more bell-shaped. The flagellum next disappears. Then marks of self-division appear in a narrow, slight furrow (Fig. 17, B, e), extending from the front half-way back along the middle of the body. Meanwhile the collar, which had become conical, expands, and, most striking change of all, two new flagella appear. Then the collar splits into two (Fig. 17), and soon the two new *Codosigæ* become perfected, when they split asunder, and become like the original *Codosiga*. Such is the usual mode of multiplication of the species in the monads.

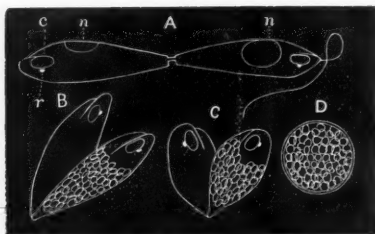
Fig. 17.



Fission of *Codosiga*.

A second mode, that of becoming encysted, has been rarely observed. Carter, so far as we are aware, was the first to attempt to trace the life history of a monad. We copy the following figures from his memoir. Fig. A represents two *Euglena viridis* in conjunction; n, the nucleus, c, contractile vesicle, and r, the red body; B and C the same after the breaking up of the contents into the embryonic zoospores. The two *Euglenæ* finally

Fig. 18.

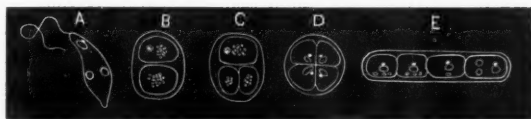


Development of *Euglena viridis*.

separate and each becomes spherical, encysted as at D. Fig. 18 illustrates the mode of development in *Euglena agilis*. A repre-

sents the adult *Euglena*, taken from the brackish water of marshes at Bombay; B, the resting stage, transverse division having taken place, and showing that the red body is not developed in the lower

Fig. 19.

Development of *Euglena agilis*.

half; D, the same, with a quadruple longitudinal division, showing that the red body is equally multiplied; E, linear development, probably by longitudinal division, as the red body is present in each cell.

We copy a portion of the figures and account of the development of *Colpodella pugnax* as given by Cienkowski. Figure

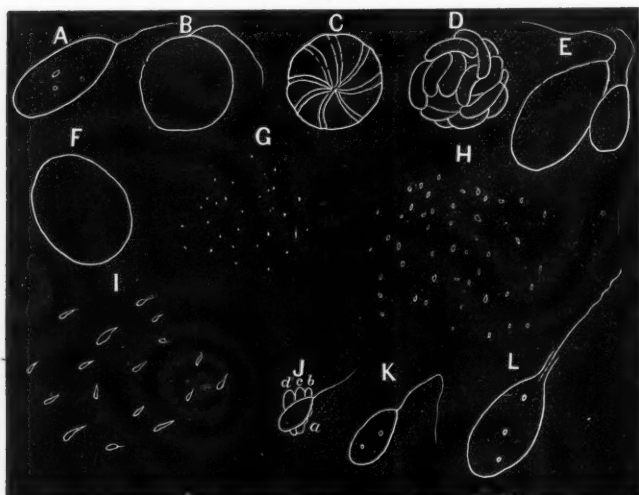
Fig. 20.

Development of *Colpodella*.

20, A, represents this monad before taking food; B represents three *Colpodellæ* in the act of absorbing the nucleus of a *Chlamydomonas*; at C is a single *Colpodella*, without the nucleus, and much swollen anteriorly. Finally the *Chlamydomonas* is, as it were, eviscerated, nothing but the body walls being left. After this wholesale plundering of the contents of the *Chlamydomonas*, it then passes into a "cell" or encysted state, as at D (α , the mass of food, colored red). The contents of the cell then break up into a number of masses, as at E, which finally, as at F (the masses destined to change into zoospores), issue from the cyst in a mass surrounded by a thin membrane, which gradually disappears, when the free zoospores make off in every direction. G represents the encysted body of the monad, without the ball of food. He also shows that another unknown monad, a species of *Bodo*, and three species of *Pseudospora* also develop by becoming encysted.

Messrs. Dallinger and Drysdale describe in two unknown monads the process of encysting and the development of zoospores, the sarcode mass passing through a process resembling the segmentation of the egg into four, eight and many spheres, each sphere ultimately becoming a monad. The changes were noticed with greater fulness of detail in another unknown monad, Fig. 21, A. When about to pass into the encysted stage it became amœboid in its form, but still very active; at the stage B, however, it became spherical and quiet, and finally lost the flagellum,

Fig. 21.



Development of a Monad.

and the contents suddenly divided into four portions, separated by a white cruciform mark or furrow. Then an intense activity pervaded the sarcode mass, "a sort of interior whirling motion" like the rushing of water "round the interior of a hollow glass sphere on its way to the jet of a fountain," as indicated at C. This action lasted from ten to seventy minutes, when it stopped and the mass broke up into small embryonic zoospores, as at D, which began a "quick writhing motion upon each other, like a knot of eels." After remaining in this state from seven to thirty minutes, they separated and swam away. Thus far they had

passed through the ordinary mode of formation of young monads, but the authors noticed among the swarm of monads some much larger, and differing from the others in being very granular towards the flagellate end. These fastened themselves upon one of the smaller common forms, Fig. 21, E, and finally absorbed it, a process certainly analogous to, if not identical with, conjugation. It then assumed a resting condition, as at F. The sphere then opened slowly and a glairy looking fluid poured out. On careful examination of this fluid, with powers of 2500 to 5000 diameters, seven hours after emission tiny dots, semitransparent and yellowish, appeared as at G. In an hour and ten minutes the dots appeared as at H; after two hours more as at I. The sharp-pointed bodies at I became rounder, and from the pointed end a flagellum developed as at J, when they were ninety minutes older than at I. At this time "motion first showed itself; this, however, was not the motion usual to the monad, but a motion of horizontal vibration from *a* through *b* and *c*, to *d*, and then back again." It then swam away, became plump as in K and then was followed into the stages from A to E, the last figure (L) representing the complete monad, thus passing through two cycles of existence.

Three modes of development in the Flagellata seem therefore established, as follows:—

1. Simple fission.
2. The production of monads by encysting.
3. The production of monads by encysting and conjugation, with a resting stage and the production of excessively minute zoospores which grow, finally becoming normal monads.

It will be seen that these methods of increase are paralleled by those observed in the Monera, the Gregarinida and the Rhizopoda. It appears that there is here nothing like a sexual development, unless we have something analogous to it in the conjugation (?) of the monads described by Dallinger and Drysdale, but which they themselves do not call conjugation, merely confining themselves to a statement of the facts observed by them.

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Clark. Spongiæ Ciliatæ as Infusoria Flagellata. (Memoirs Boston Society of Nat. Hist., 1867.)

Dallinger and Drysdale. Researches into the Life History of the Monads. (Monthly Microscopical Journal, January and February, 1874.)

VI. THE NOCTILUCÆ.

Tossed from one place to another among the Protozoa, we have now, thanks to the researches of Cienkowski, certain grounds for placing the Noctilucae near, if not among the Flagellata, from the resemblance of the zoospores to the monads; while they seem to form a more highly developed type. It thus appears that by a study of the mode of growth of the Protozoa, as in the rest of the animal world, we can alone obtain correct ideas as to the affinities of the respective groups.

The Noctiluca (Fig. 22) is a highly phosphorescent organism, so small as scarcely to be seen with the naked eye, being from .01

Fig. 22.



Noctiluca miliaris.

to .04 inch in diameter. It occurs in great numbers on the surface of the sea. It has a nearly spherical jelly-like body, with a groove on one side from which issues a curved filament, used in locomotion. Near the base of this filament is the mouth, having on one side a tooth-like projection. Connecting with the mouth is an œsophagus which passes into the digestive cavity, in front of which lies an oval nucleus. Beneath the outer skin or firm membrane surrounding the body is a gelatinous layer, containing numerous granules. A network of granular fibres arises from the granular layer; these fibres pass into the middle of the body to the nucleus and digestive cavity.

Development. Baddely had noticed a multiplication by division and reproduction by internal buds, and Busch had observed round, transparent disks, of the same size, consistence and optical properties as the Noctilucae occurring among them, but could not determine what relations they bore to the former. It was, however, reserved for Cienkowski to trace the development of monad-like zoospores in these reproductive bodies. Fig. 23 represents these zoospores. They move about by a long flagellum. The tooth-like process (s) is thought by Cienkowski to be a rudimentary condition of the "whip" near the mouth of the adult Noctiluca. By keeping specimens in a drop of water on a thin glass which was placed over a moist chamber so as to ex-

Fig. 23.



Zoospores of Noctiluca.

clude all access of dry air to the water in which the animals were living, he was enabled to observe them for twelve hours. The stages he observed were—

“1st. Noctiluca-like bodies, but without mouth or lash, and having a doubly spherical or so-called biscuit form, each partial sphere having a granular protoplasmic mass with fine branching rays, the two masses being connected more or less. 2d. The protoplasm connects so as to form a disk on one pole of the irregular double spheroid, which gradually becomes spherical, exhibiting three or four depressions at one pole. 3d. The formation of the disk is preceded by a segmentation of the entire mass of the protoplasm of the Noctiluca into two, four, eight, sixteen, etc. parts, after which the disk begins to grow up on the surface of the Noctiluca. 4th. The protoplasmic disk sends out stumpy processes which project from the surface of the spheroid and exhibit peculiar wriggling movements. 5th. The mass commences to divide into smaller pieces, the vesicle being now quite spherical. The commencement of this division was not directly observed, but later stages, in which clumps of protoplasmic matter were seen arranged at first in groups of eight; these, then, were followed carefully through their division into groups of sixteen irregular, oblong particles. These products of division appear like denser, sharply-defined masses or nuclei, lying in a less dense surrounding granular plasma. 6th. The next stage was one of the first and most commonly observed, in which the protoplasmic disk, formed as above described, has become entirely split up into small oval bodies, each .016 millimetre long. The aggregated mass of these oval spores sometimes appears as a disk at one pole of a Noctiluca-like vesicle, or as a girdle passing round it. 7th. By high powers each oval particle is seen to have a terminal cilium, and whilst under observation many were seen to separate from the disk and swim about as free swarm-spores” (Fig. 23).

Cienkowski also observed the fusion of two Noctilucae. “The two animals place themselves with the two so-called ‘oral apertures’ close to one another, and through these a protoplasmic bridge is formed, which unites the nuclei of the two individuals. Later, at the points of contact, the outlines of the two Noctiluca-vesicles fuse, and thus the double-spheroid or biscuit-shaped bladders are formed. By further fusion the pinching in of the vesicle disappears from one side, so that the vesicle becomes more nearly

spherical. Meanwhile the two nuclei become completely fused into one, retaining, however, their radiating threads and network, as in normal individuals. The cross-striped 'lashes' and the 'teeth' of the two fused Noctilucae also disappear. All trace of the double origin of these 'copulated Noctilucae' may pass away by the disappearance of the fold on the surface, near to which the nucleus lies, and thus a Noctiluca vesicle is formed, which is always larger than the normal Noctiluca, and seems identical with the bodies noticed by Busch, and also very probably identical with the biscuit-shaped and spherical Noctiluca vesicles in which Cienkowski has traced the formation of the swarm-spores. A direct observation of the formation of swarm-spores in the copulated forms Cienkowski was not able to obtain."

This fusion of two Noctilucae is not, however, essential for the production of zoospores, as they appear whether conjugation has occurred or not. When it does occur, however, it seems to be of a sexual nature. Conjugation, though by no means necessary, does frequently take place, and "as in the fusion of the zoospores of Myxomycetæ, and the copulation of Actinophrys, and others, leads to an augmentation of the mass of the protoplasm." "Zoospores," he adds, "occur in quite small Noctilucae, which certainly could not be the product of the fusion of two individuals. Sometimes the zoospores develop very rapidly whilst still in the disk, and their protoplasm becomes differentiated into a nucleus and radiating threads." Cienkowski considers that the zoospores of Noctiluca decide the systematic position which must be assigned to this organism. It seems to him that they are animals of large dimensions belonging to the division of the Flagellata.

A single mode of growth, therefore, occurs in Noctiluca, *i.e.* development from zoospores.

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THE WHEELER GEOLOGICAL SURVEY OF NEW MEXICO FOR 1874.

BY E. D. COPE.

THE Engineer Topographical and Geological Survey west of the 100th meridian, under Lieut. Geo. M. Wheeler, left Pueblo during the month of July for the prosecution of their labors in New Mexico. It was divided into eight parties, of which six were primarily topographical and two devoted to geological and biological investigation.

Of the former one only, that under charge of Lieut. Blunt, operated east of the Rocky Mountains, while the remaining five surveyed from the Colorado line, or near it, southward as far as the Rio El Rito and Cañon Apache, in the following order: at the north Lieut. Marshall; then Wheeler, Whipple, Birnie, and last, Lieut. Price. The last named officer having been incapacitated by sickness was succeeded in charge by Mr. Klett. The two remaining parties were assigned extensive territorial areas, as the nature of their work required widely extended reconnoissances, as well as studies in special localities, the position of which could not be foreseen. Dr. Rothrock was in charge of a party which explored the botany and zoology of southern Arizona and New Mexico, and Dr. Yarrow and Prof. Cope investigated the geology and paleontology of the northern portion of the latter territory.

We propose to speak of the work of the last named party at present, as several of the others have not yet come in from the field. Dr. Yarrow having left for Washington about the middle of September, according to previous arrangement, the direction devolved on the writer. The results obtained have been highly interesting and important to geological science. An analysis of the structure of the region traversed between Pueblo and Santa Fé was accompanied by successful collecting of fossil remains in many of the strata. Thus the Cretaceous beds near the Huerfano yielded many fine fossil shells and teeth of extinct fishes, and the carboniferous limestone of the Sangre del Christo pass was found to be equally rich. A unique collection of a large number of most beautifully preserved invertebrate remains was procured

from the same formation near Taos. Below the Picoris Mountains the sand beds and bluffs of the Pliocene formation fill the valley of the Rio Grande. These are the deposits of a lake of comparatively modern age, and in some localities they abound in remains of the skeletons of the animals that inhabited the surrounding continent at that time. Mastodons of species quite different from that so frequently found in the Eastern states were found to be abundant, while camels and horses had evidently existed in droves. One of the most singular discoveries was that of deer which did not shed their horns, as do modern species of that type. There is abundant reason to believe that they were frequently broken off in combats, so that while some individuals of a species had solid horns like the giraffe, others of the same species had them united by a suture with a burr like the deer. To keep the herbivorous animals in check, there were several species of wild dogs, while a large vulture allied to the turkey buzzard was prepared to eat them when life had departed, as the fossil remains demonstrate.

After concluding the investigation of this basin, the geologist was enabled through the courtesy of Gen. Gregg commanding the district of New Mexico, to make an exploration of the geology of the region at the northern end of the Zandia Mountains, forty miles south of Santa Fé. Here numerous fossil remains were found, including those of the hairy elephant, *Elephas primigenius* (var. *Columbi*). The party, after examining the geology of the Eastern Jemez mountains, passed north to Abiquiu on the Rio Chama and through the cañon Canjelson to Tierra Amarilla.

The writer had been led to suspect the existence of a tertiary lake basin on the divide of the drainage of the Chama and San Juan rivers, and had already published his belief that the rich life of the Eocene period of Wyoming had been preceded by older forms, which had lived upon older territory in the southern regions of the great basin. This position was fully confirmed by my discovery in the region in question of an enormous mass of lacustrine deposits of some 3000 feet in thickness, which cover an area of at least 3000 square miles (probably more) which includes remains of the oldest mammalian fauna of the continent, and which corresponds with the lowest of the fossil bearing beds of Wyoming. About 100 species of vertebrate animals were obtained, of which two-thirds are mammalia, and a large percentage new to

science. The crocodiles were very numerous and turtles swarmed. The mammalia did not embrace many of the modern classes, but exhibit, according to the preliminary reports published by direction of Lieut. Wheeler, characters of orders of which little has been known. The largest species were those of the genus *Bathmodon*, of which five species were discovered, which range from the size of the Indian rhinoceros to that of the tapir. They resembled closely the elephants in the structure of the feet and legs, but the tapir and the bear in the characters of the skull. They were armed with most formidable tusks, and their crania were solid and well thickened to repel attack. Besides these there were numerous species more nearly resembling the tapirs, and in some remote degree the horses, of a more harmless type, while a numerous population of carnivora restricted the increase of the rest. Sixteen species of flesh-eating forms were found, some of them minute, and others of powerful make, but all far removed from the existing types, and more or less related in structure to other kinds of quadrupeds, especially to those of insectivorous habits. Some of them possessed teeth of extraordinary strength, and were apparently bone breakers, while the excessively worn condition of the teeth and tusks of some others indicate hard diet and friction against resisting bodies. An order of very peculiarly constructed animals was represented by several species. These had much the structure of the gnawing order (*Rodentia*) in their dentition, which, however, includes many peculiarities, but resembled some of the hoofed animals in their feet. The only known example of this order (the *Toxodontia*) had been previously obtained from the late tertiary deposits of South America.

The boundaries of this lake basin were pretty well determined, and attention directed to the structure of the hill and mountain regions which constituted its shores. Among these were found marine and fresh water formations, containing abundant fossil remains, with beds of lignite of fifty feet or more in thickness. One of the lake deposits contains an abundance of petrified wood, while a lower formation was found to contain the teeth and bones of saurians of large proportions, and apparently of greater antiquity than those heretofore obtained in the West.

The brilliant colors of some of the strata observed are very remarkable, and the scenery is rendered highly picturesque by the escarpments of obliquely elevated strata, which traverse the coun-

try for sixty miles and more, parallel to the mountain axis. Most curious are the remains of human dwellings which stand in lines on the summits of these rock crests, and almost all the more inaccessible and remote points of the hills. They were often found standing on the summits of ledges of from five to twelve feet in width, with precipices of several hundred feet in depth on one or both sides; or occupying ledges on the sides of precipices forming the walls of cañons, in positions only accessible by perilous climbing. These localities are often remote from water, in some cases more than twenty miles.

The party collected and brought within reach of transportation about a ton of fossil remains. They crossed directly from the Rio Puerco to Conejos over the San Juan Mountains by a pass some twenty miles in length, where they were overtaken by a severe snowstorm. They returned to Pueblo on the 11th of November.

REVIEWS AND BOOK NOTICES.

EMBRYOLOGY OF THE CTENOPHORÆ.¹ — The development of certain jelly fishes (Ctenophoræ) belonging to the genera *Idyia* and *Pleurobrachia* has been elaborated in this memoir with great care and beauty of illustration by Mr. A. Agassiz. He gives a connected account of their history from the earliest stages in the egg until all the features of the adult appear. While the mode of segmentation of the yolk is extraordinary, the embryo attains the adult form without any metamorphosis, the changes being very gradual. Mr. Agassiz's observations, with the preceding ones of Müller, Gegenbaur, Kowalevsky and Fol, give us a tolerably complete view of the mode of development of this order of jelly fishes. These Ctenophoræ on our coast spawn late in the summer and fall. The young brood developed in the autumn comes to the surface the following spring nearly full-grown, to lay their eggs late in the summer. The autumn brood most probably passes the whole winter in deep water, and it must take six to eight months for the young to attain their maturity. The memoir closes with

¹ Embryology of the Ctenophoræ. By Alexander Agassiz, with 5 plates and figures printed in the text. From the *Memoirs of the Amer. Acad. Arts and Sciences*, x, Aug. 1874, 4to, pp. 41.

a vigorous and trenchant criticism of Haeckel's *Gastrula* theory, exposing its weak points. Mr. Agassiz regards the assumptions of Haeckel forming the basis of his *Gastrula* theory as "wholly unsupported." It must "take its place by the side of other physio-philosophical systems," and he denies that we have been "able to trace a mechanical cause for the genetic connection of the various branches of the animal kingdom."

ENTOMOLOGY IN ILLINOIS.¹—We have noticed previously the important entomological reports made by Mr. Riley to the state of Missouri; we now have before us a Report of about two hundred pages by the state entomologist of Illinois. It is fully illustrated by admirable drawings mostly from the pencil of Mr. Riley, and is well printed. Instead of treating directly of injurious insects, it is a treatise on the beetles of the United States, and as such will serve to prepare the way for future reports on economic entomology. The work is excellent as an introduction to a study of the beetles, which comprises some of the most injurious species, and we bespeak for it a large circulation outside of the state. We could find some fault with the general classification of the insects, but the aim of the work and successful treatment of the subject preclude such criticism. The transformations of a number of new beetles are described and figured.

POLARIZATION OF LIGHT.²—This is another of the elegant and popular treatises reprinted with additions and new plates from "Nature." They contain the substance of lectures delivered at various times to workpeople, and "constitute a talk rather than a treatise on polarized light," says the author.

BOTANY.

DO VARIETIES WEAR OUT OR TEND TO WEAR OUT?—In an interesting article on this subject in the New York "Tribune," Prof. Gray discusses this question, and concludes that "sexually propagated varieties, or races, although liable to disappear through change, need not be expected to wear out, and there is no proof that they do; also, that non-sexually propagated varieties, though

¹ Fourth Annual Report on the Noxious and Beneficial Insects of the State of Illinois. By William LeBaron, M.D. Springfield, 1874. 8vo, pp. 199.

² Polarization of Light. By William Spottiswoode, LL.D., F.R.S. Nature Series. London. Macmillan & Co. 1874. 12mo, pp. 129, with plates and cuts. Price \$1.00.

not liable to change, may theoretically be expected to wear out, but to be a very long time about it."

CYPRIPEDIUM SPECTABILE.—Last spring I found on East Mountain, Williamstown, two flowers of the *Cypripedium spectabile* Swartz, growing from the same stalk, one of which was the regular color, nearly all purple, and the other was pure white.—J. S. KINGSLEY.

ZOOLOGY.

NOTE ON STERNA LONGIPENNIS NORDMANN.—In the NATURALIST for July, 1874 (p. 433), a tern, "new to the Atlantic coast of North America," was described by me under the name of *Sterna Portlandica*—in event it should prove distinct from *S. longipennis* Nordm., with which Dr. Coues identified Mr. Lawrence's *S. Pikei* (see Key, p. 320). At that time no specimen of Nordmann's species existed, so far as known, in the United States, so that a satisfactory comparison could not be made, while the new bird did not agree well with the description of *S. Pikei* in the ninth volume of the Pacific Railroad Reports (p. 863). In order to settle the question of the relationship of *S. Portlandica*, Dr. Otto Finsch, Curator of the Bremen Museum in Germany, kindly forwarded to the Smithsonian Institution the only specimen of *S. longipennis*, a fine example, in perfect plumage, procured at the sea of Baikal, Siberia, June 3, 1870. Having thus an opportunity of actual comparison of specimens, the results are herewith given:

Sterna longipennis Nordmann is very closely related to *S. hirundo*, from which it scarcely differs more than as a geographical race, and is very distinct from both *S. Pikei* and *S. Portlandica*. The degree of relationship between the four forms is shown below:

A.—Beneath ashy white; nape pale pearl-gray; forehead black in summer; feet red. Tarsus .70 or more; culmen 1.40 or more.

Bill red, the terminal third black. Wing, 10.35; tail, 6.50; depth of fork, 3.10; culmen, 1.50; depth of bill, .30; tarsus, .80; middle toe, .68.

S. HIRUNDO.

Bill black, the upper mandible beneath the nostril and the basal two-thirds of the lower inclining to reddish. Wing, 10.35; tail, 6.30; depth of fork, 2.55; culmen, 1.50; depth of bill .30; tarsus, .75; middle toe, .68.

S. LONGIPENNIS.

B.—Beneath snowy-white; nape pure white; forehead wholly white in summer; feet black or red; tarsus .60 or less; culmen, 1.25 or less.

Bill deep black; feet deep black. Wing, 9.60; tail, 6.00; depth of fork, 2.60; culmen, 1.15; depth of bill, .25; tarsus, .55; middle toe, .60.

S. PORTLANDICA.

Bill dusky reddish; feet reddish. Wing, 9.00; tail, 5.50; culmen, 1.12; tarsus, .50.

S. PIKEI.

S. longipennis agrees very closely with both *S. hirundo* and *S. macroura* in the main points of coloration, having the same decided grayish tinge to the lower parts and nape, and the forehead black. The specimen compared, however, differs from both these species in having the white terminal borders to the longer scapulars, tertials and inner primaries much less distinct; the outer surface of the primaries is more silvery, and the black of the nape appears to extend farther down, terminating at about 3.00 from the base of the culmen instead of at less than 2.50. Whether this last feature depends upon the "make" of the skin is uncertain.—ROBERT RIDGWAY.

GEOLOGY AND PALEONTOLOGY.

NEW FORMS OF ELASMO-SAURIDÆ. —Professor H. G. Seeley has recently examined the structure of the reptiles found in the English formations referred by authors to the old genus *Plesiosaurus*. He finds that the modifications in the structure of the scapular arch are such as to require their reference to two families, the *Plesiosauridæ* and *Elasmosauridæ*. The former embraces only the genus *Plesiosaurus*; the latter includes *Elasmosaurus* and three new genera, namely, *Eretmosaurus*, *Colymbosaurus* and *Muraenosaurus*. The characters distinguishing these genera are principally discoverable in the scapular arch.—E. D. C.

AMERICAN TYPES IN THE CRETACEOUS OF NEW ZEALAND.—Mr. Hector, the paleontologist of New Zealand, has obtained and described the remains of numerous extinct reptiles which present various points of resemblance to those disclosed by explorations in Kansas, and described in Dr. Hayden's annual reports. Thus he finds a species of *Polycotylus* and a form which he states to be allied to *Elasmosaurus*, called *Tanivasaurus*. He adds a number

of species of *Pythonomorpha*, among which are a *Liodon*, with a conic muzzle, and a new genus allied to *Clidastes*. Other species are referred to the true *Plesiosaurus*.—E. D. C.

A NEW MASTODON.—The Mastodon of the Santa Fé marls turns out to be distinct from the *M. Chapmani* of the East, and the *M. Shepardii* of California, and is allied to the *M. longirostris* of Europe. It has been named *N. productus* Cope. The presence of the genera of Mammalia characteristic of the Pliocene formations of Nebraska and Colorado refers these beds to the same horizon. A report on the paleontology of the formation is just issued by the Chief of Engineers, Washington.—E. D. C.

ANTHROPOLOGY.

CREMATION AMONG NORTH AMERICAN INDIANS.¹—The object of the present note is merely to record the fact, that among the many different methods of paying the last tribute of respect to deceased members of the tribe, which are now practised by the native races of North America, cremation is not entirely omitted.

In December, 1850, while enjoying the hospitality of the detachment of the 2nd U. S. Infantry, which at that time established Fort Yuma, the military post at the junction of the Colorado and Gila Rivers in California, I availed myself of the kind offer of Mr. Jordan, one of the owners of the ferry near the post, to make with him an exploration of the river below the junction.

Starting in a small flat boat, which he generously sacrificed for the purpose, with a Yuma Indian, who had a feeble knowledge of Spanish, as guide and interpreter, we floated down with the current of the river, making, by the aid of a solar compass, a rough survey. On the afternoon of the third day we arrived at the lowest village of the Cocopa Indians, who are the next tribe south of the Yumas. Below that village we were told that the spring tides widely overflowed the banks of the river, and that if we went farther, the softness of the mud might seriously hinder our return.

The next day I learned from the guide that an old man had died in a village near the east bank of the river, and that the body was to be burned.

¹ Read at the Hartford Meeting Amer. Assoc. Adv. Sci.

Never having heard before that this custom existed in North America, we eagerly availed ourselves of the opportunity of seeing the interesting ceremony. Crossing the stream in our flat boat, we arrived, after a walk of a couple of miles over the river bottom and adjoining desert, at the late residence of the deceased.

A short distance from the collection of thatched huts which composed the village, a shallow trench had been dug in the desert, in which were laid logs of the mesquite (*Prosopis*, and *Strombo-carpus*), hard and dense wood, which makes, as all western campaigners know, a very hot fire, with little flame, or smoke. After a short time the body was brought from the village, surrounded by the family and other inhabitants, and laid on the logs in the trench. The relatives, as is usual with Indians, had their faces disfigured with black paint, and the females as is the custom with other savages made very loud exclamations of grief, mingled with what might be supposed to be funeral songs. Some smaller faggots were then placed on top, a few of the personal effects of the dead man added, and fire applied. After a time, a dense mass of dark colored smoke arose, and the burning of the body, which was much emaciated, proceeded rapidly. I began to be rather tired of the spectacle, and was about to go away, when one of the Indians, in a few words of Spanish, told me to remain, that there was yet something to be seen.

An old man then advanced from the assemblage, with a long pointed stick in his hand. Going near to the burning body he removed the eyes holding them successively on the point of the stick, in the direction of the sun, with his face turned towards that luminary, repeating at the same time some words, which I understood from our guide was a prayer for the happiness of the soul of the deceased. After this more faggots were heaped on the fire which was kept up for perhaps three or four hours longer. I did not remain, as there was nothing more of interest, but I learned on inquiry, that after the fire was burnt out, it was the custom to collect the fragments of bone which remained, and put them in a terra cotta vase, which was kept under the care of the family.

The ceremony of taking out the eyes, and offering them to the Sun, seems to indicate a feeble remnant of the widely diffused Sun worship of former times, but when introduced, or whence derived, I could not learn. The subject appears to me an important

one, and to deserve attention from those who are so situated as to procure further information.

None of the Cocopas whom I met had sufficient knowledge of Spanish to enable me to communicate easily with them, so that I learned little of their history or habits, during the two days that I remained among them. I however wrote down their numerals and a few other words, which were sufficient to confirm the information I afterwards obtained.

On a subsequent journey along the Gila to Tucson and other towns, then belonging to the Mexican state of Sonora, I passed through the villages of the Coco-maricopas who, as is well known to all of my hearers, live in a semi-civilized condition, in close bonds of union with the Pimos, on the banks of the Gila.

I was led by the similarity of language, as well as by the resemblance in name, to suspect that this tribe was related to the Cocopas of the lower Colorado. On enquiring, I was told by one of the chiefs, Francisco Duk, that they still preserved a tradition of the former connection of the two tribes. Many years ago, in search of more extensive lands, the Cocopas had separated from them, and gone westward, settling on the banks of the Colorado, below the confluence of the Gila. Visits were occasionally made to their villages by their kinsmen from the Colorado, and in fact, I had met on my journey a small party of Cocopas returning from the Maricopa villages.

The Maricopas are now completely identified in interests and habits with the Pimos, and if they practised cremation when they first entered the Gila valley, the usage has long since become obsolete.

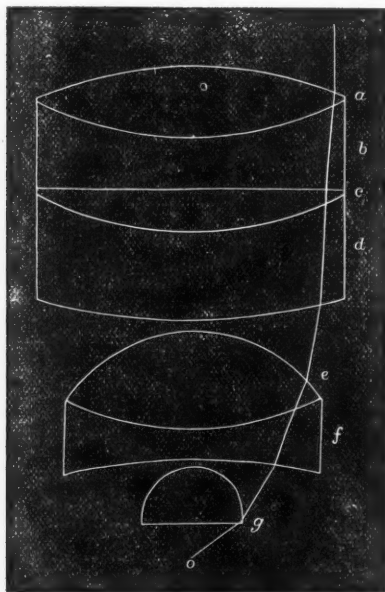
Commercial intercourse between the Indians of these interior valleys and those of the Californian Gulf must have also taken place centuries ago, when a higher form of semi-civilization existed along the Gila. For not many days afterwards while examining the famous Casas Grandes or Casas Blancas, as they are more usually called, I found shells of the genera *Oliva* and *Conus*, which had been brought from the Gulf. Small ornaments of turquoise, similar to the variety found near Santa Fé, New Mexico, occasionally occur and are greatly prized by the Indians.

MICROSCOPY.

ANGULAR APERTURE.—The discussion upon this question which was tedious a year or two ago has become interesting now, and the utilization of the extra-limal rays (in immersion objectives as compared with dry ones) which was first published as a definite theory by Dr. Woodward, in the "Monthly Mic. Journ.," and editorially in the *NATURALIST*, in an article which was written independently, and was in type at the same time, seems likely to prove to be one of the few great steps of progress in the development of the microscope. Before that time Mr. Wenham, and some others, had strenuously insisted upon teaching the reduction of the (nearly) 180° dry angle to about 82° immersion angle, and in so doing had been led, apparently unconscious of saying materially more than that, into a denial of the possibility of constructing an objective capable of using a larger angle than that; and Mr. Tolles, and no others, had as firmly insisted on his ability to enlarge the angle without any definite or assignable limit: the one party had argued a natural limit and nothing further, and the other party had denied a limit and appealed to his work for proof, but neither party was understood to have established the doctrine of the utilization of the extra-limal rays by admitting the limit, and at the same time showing how that limit may be passed without conflicting with well established theory. When this explanation was published it seemed so reasonable and so consistent with the assertions of both parties, that it was supposed both would say that it was precisely what they meant all the time. Mr. Tolles promptly did this, but Mr. Wenham, to the surprise of many of his friends, denied and still denies the whole doctrine, and what is more strange is satisfied with a measurement of one of Mr. Tolles' glasses as a final disproof of so fundamental and important a theory. The exact angle of a certain $\frac{1}{6}$ made by Mr. Tolles, and whether it exceeds 82° or not, is of some consequence to Mr. Tolles and his customers, but is of little importance to the world of science, compared with the theoretical possibility of exceeding that limit; and Mr. Wenham is, perhaps, one of the last persons in the world who would have been expected to fall into any doubt or confusion at this point. At the same time as Mr. Tolles was the first, and still is the only

one known to claim to make lenses in which the extra-limal rays are turned to good account, it is only justice to him to mention his name in connection with them, just as Huyghens and Kellner are credited with the negative and orthoscopic oculars, and Wenham with the binocular prism and the simple front objective. The exact comparative efficiency of the extra-limal immersions is yet undetermined, though they would be expected to have certain strong working points; a theory that seems fully justified, even

Fig. 24.



after making all possible allowance for the enthusiasm of those possessing and using a novelty, by the trials already made of some of the lenses.

Of all the contributions to this subject none probably excel in interest and importance the mathematical computation of the course of the light through the $\frac{1}{10}$ inch objective at the Army Medical Museum, by Prof. R. Keith, of Georgetown, a synopsis of which was published in the September Number of the "Monthly Microscopical

Journal," and for the full details of which we are indebted to the courtesy of Prof. Keith. Nor is the interest of this elaborate mathematical analysis appreciably lessened by Mr. Wenham's doubt, as to the reliability of the data furnished by Mr. Tolles as a basis for the computation; since if the data do not accurately represent the construction of that objective they at least seem to represent a practicable combination of lenses, which might be made into an objective, and that is what we want to know, and what the long discussion has derived its cat-like life from. The objection in question consists of seven lenses; a quadruple back consisting of a double-convex of crown glass, a plano-concave of flint, a plano-convex of crown and a meniscus of flint, a double middle formed by the union of a double-convex of crown and a double-concave of flint, and a simple hemispherical front of crown. The plan of grinding the lenses as thin as possible is discarded, as in much recent work, and some of the lenses are quite thick at the thinnest point. The following figures represent the data of construction, the letters *a* to *g* representing the seven lenses in regular order, beginning with the upper lens of the back combination (See also Fig. 24).

	a.	b.	c.	d.	e.	f.	g.
Index of Refraction.	1.525	1.620	1.525	1.620	1.525	1.654	1.525
Radius of Curvature:							
First surface.	∞	∞	∞	∞	∞	∞	∞
Second surface.	∞	∞	∞	∞	∞	∞	∞
Thickness at centre.	.048	.027	.033	.047	.062	.02	.035
Diameter.	.2	.2	.2	.2	.165	.165	.066

Distance of back combination from middle .008. By screw collar adjustment the front is set at a distance of .00528 from the next surface. The light is assumed to start from a point ten inches above the first (back) surface, and is traced through the objective to a focal point below. The table on p. 62 represents the distance from the axis at which the extreme ray crosses each surface, and the angles which the ray, before crossing, makes with the axis. The negative sign indicates convergence of light.

This gives a computed angular aperture of $110^{\circ} 35' 10''$, which largely exceeds the 87° obtained by measurement by Dr. Wood-

ward; but the very reasonable allowance of .00162 for the setting of the front lens, reduces the computed to the observed angle. By computation the spherical aberration is almost nothing, which also corresponds with Dr. Woodward's statement, based upon the performances of the lens in actual use. Though constructed for immersion use only, Dr. Woodward states that it works well dry at near open point.

First surface.	0.00250	+ 0° 31' 45"
Second "	0.00139	— 6 51 51
Third "	0.08742	— 4 37 23
Fourth "	0.08625	— 4 54 42
Fifth "	0.08318	— 2 57 30
Sixth "	0.07391	— 11 1 3
Seventh "	0.06625	— 24 37 5
Eighth "	0.05324	— 20 8 0
Ninth "	0.03300	— 29 44 7
Tenth "	0.00000	— 55 17 35

TOLLES' NEW $\frac{1}{10}$ TH vs. OLD $\frac{1}{50}$ TH.¹—I am indebted to my friend Mr. J. Edwards Smith, of Ashtabula, O., for the loan of his old Tolles' $\frac{1}{10}$ th, the first lens, so far as I know, that showed *A. pellucida* in dots, and also his new Tolles' $\frac{1}{16}$ th objective. Both glasses failed in my hands, with eye-pieces as high as Beck's No. 3, to do as well as my Tolles' 3 system $\frac{1}{50}$ th: but the performance of the $\frac{1}{16}$ th was so very fine for a glass of such low power, that I at once ordered one of like construction; thinking that such a glass could be relied upon in the study of objects too thickly covered to permit the use of the higher-power objective.

The one sold me by Mr. Stodder is marked "Tolles' $\frac{1}{10}$ th Immersion, Balsam angle 88°." Its air angle, as billed by Mr. Stodder, is 180°. It works well through the covers generally used for test objects.

I was greatly surprised at the exquisite performance of this glass. The best work of the $\frac{1}{50}$ th, either by day or lamplight illumination, was at once excelled; the advance being of so decided a character as not to permit of doubt.

A certain *Lepisma* scale that I had carefully studied for a long

¹ Read before the Memphis, Tenn., Microscopical Society, Dec. 3d.

time with the $\frac{1}{5}$ th and other glasses, and had seen under many favorable conditions, was instantly displayed by the four-system $\frac{1}{10}$ th clearer and better in every respect than I had before seen it. With this superb definition it appeared in ridges and corrugations, not beads; thus confirming the conclusions arrived at previously.

The superiority of the new glass is also evident on the most difficult natural tests known, such as *A. pellucida*, *N. crassinervis*, *F. saxonica* and *Nitzschia curvula*, the transverse striæ showing well, by lamplight, on all of them whether mounted dry or in balsam. The longitudinal lines of *Suirella gemma* are strongly seen; and such coarsely marked shells as *P. angulatum*, are splendidly illustrated with central light. This method of illumination readily brings to view the minute hexagons of *Triceratium favus* in balsam, a more difficult test than *angulatum*; and also shows *S. gemma* well broken up.

An exquisite definition of the scales of *Podura* and *Degeeria*, gives no semblance of beading, although the ridges are better defined than I have ever seen them before.

For an eminent optician to surpass his own best glasses of the highest powers, with objectives of an improved plan of construction and of as low power as $\frac{1}{10}$ th, is surely a triumph worth recording, and gives promise of still further advance.—G. W. MOREHOUSE, *Wayland, N. Y., Nov., 1874.*

REMARKS ON MR. MOREHOUSE'S PAPER.¹—Referring to Mr. Morehouse's observations on *Podura* and *Lepisma*, I desire to say that I have diligently studied these scales with the new 4 system $\frac{1}{8}$ th and $\frac{1}{10}$ th objectives, and that I thoroughly endorse what he has written. I have never discovered the slightest semblance of the "beading" set forth by some observers. With the objective out of proper correction, it is indeed easy to get appearances that might mislead a novice.

Regarding the performance of the $\frac{1}{8}$ th, I beg to add, that its maximum cannot be obtained with eye-pieces less than a *D* solid. Even when employing lamp illumination, I often get "decided added force" by using the $\frac{1}{4}$ th inch solid (=F). With blue sunlight the $\frac{1}{8}$ th will bear the $\frac{1}{4}$ th inch solid effectively.—J. EDWARDS SMITH, *Ashtabula, O., Nov., 1874.*

¹ Read before the Memphis Microscopical Society, Dec. 3d.

NOTES.

"THE Natural History Association of North-western College," at Naperville, Illinois, has recently completed its organization. The following are the officers:—J. L. Rockey, President; A. Goldspohn, Vice President; J. W. Troeger, Secretary; C. F. Rassweiler, A. M., Treasurer; Professor H. H. Rassweiler, Curator; Miss N. Cunningham, Directress of the Botanical Department; C. H. Dreisbach, Director of the Mineralogical and J. W. Troeger, of the Zoological Departments.

THOSE who remember the ingenious section cutter figured and described in a late number of the NATURALIST will be pleased to know that L. Schrauer, 13 Edgerly Place, Boston, has the patterns, and can furnish them to order. He has made one for the Botanic Gardens, Cambridge, and it works admirably. He is endeavoring to establish a business in this branch of work including microscope stands and apparatus connected with it, and we can highly commend his work.—E. S. MORSE.

[We cordially recommend Mr. Schrauer as an excellent workman.—EDITORS.]

The skeletons of five Indians were recently exhumed by several members of the Essex Institute, in Marblehead. A farther account will appear in our next number. The skeletons were photographed in situ, and copies of the photographs are for sale by the Naturalists' Agency.

THE undersigned is about to publish his long projected monograph of Geometrid moths, and designs giving a figure of each species. To make the work as complete as possible specimens of this family are earnestly desired for study and will be carefully returned, or other specimens sent in exchange.—A. S. PACKARD, Jr.

EXCHANGES.

Mounted Microscopic Objects wanted in exchange for handsomely illustrated Geological Reports. Address Rev. I. F. Stidham, 171 South 3d Street, Columbus, Ohio.

Pacific Algae in exchange for specimens from the Atlantic coast of the United States. Address Rev. A. B. Hervey, 10 North Second Street, Troy, N. Y.

Wanted. A small quantity of the New or West Nottingham diatomaceous earth (or information in regard to locality). A good exchange offered. Address Frank Miller, P. O. Box 142, East New York, Kings County, N. Y.

